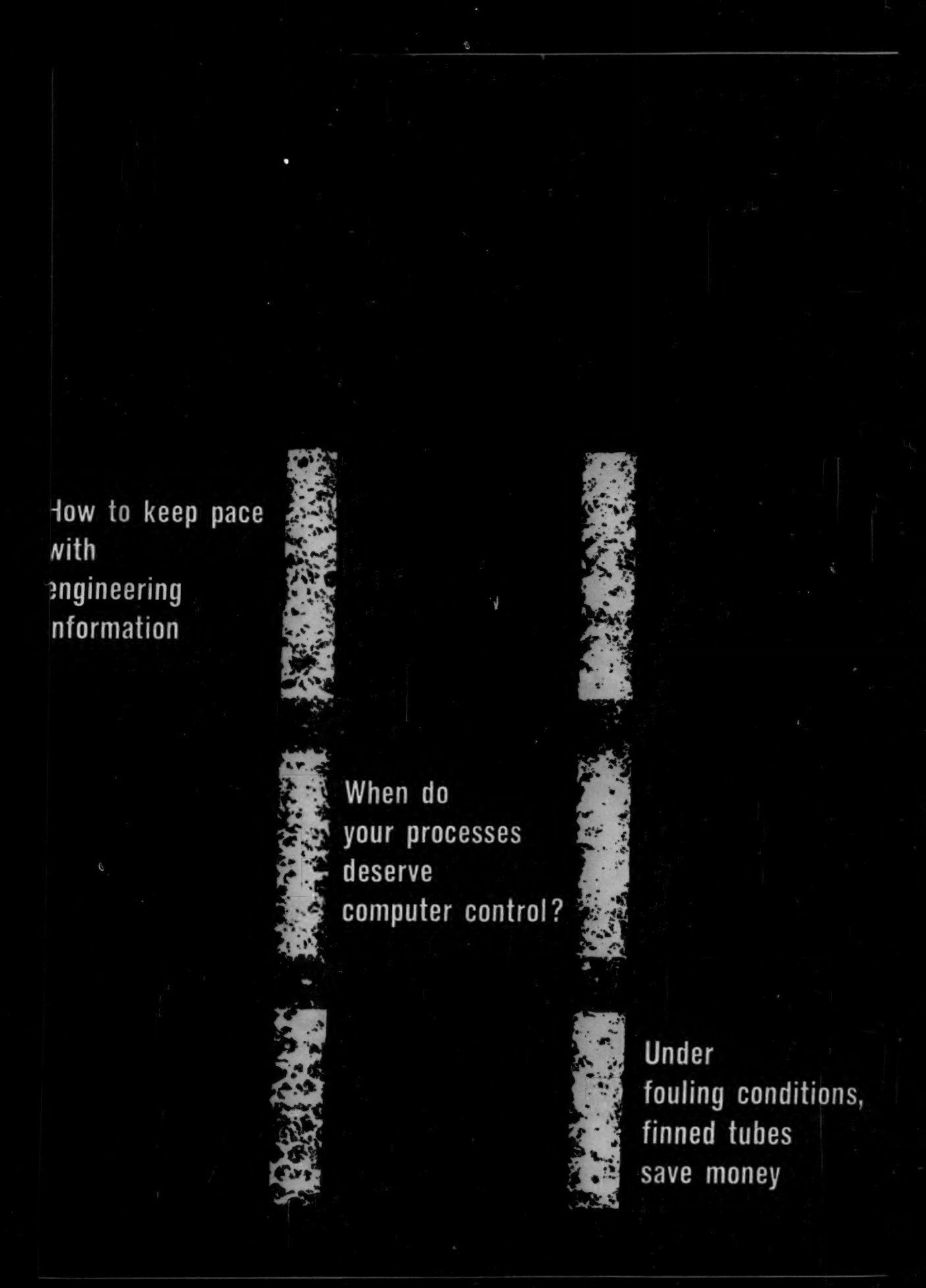
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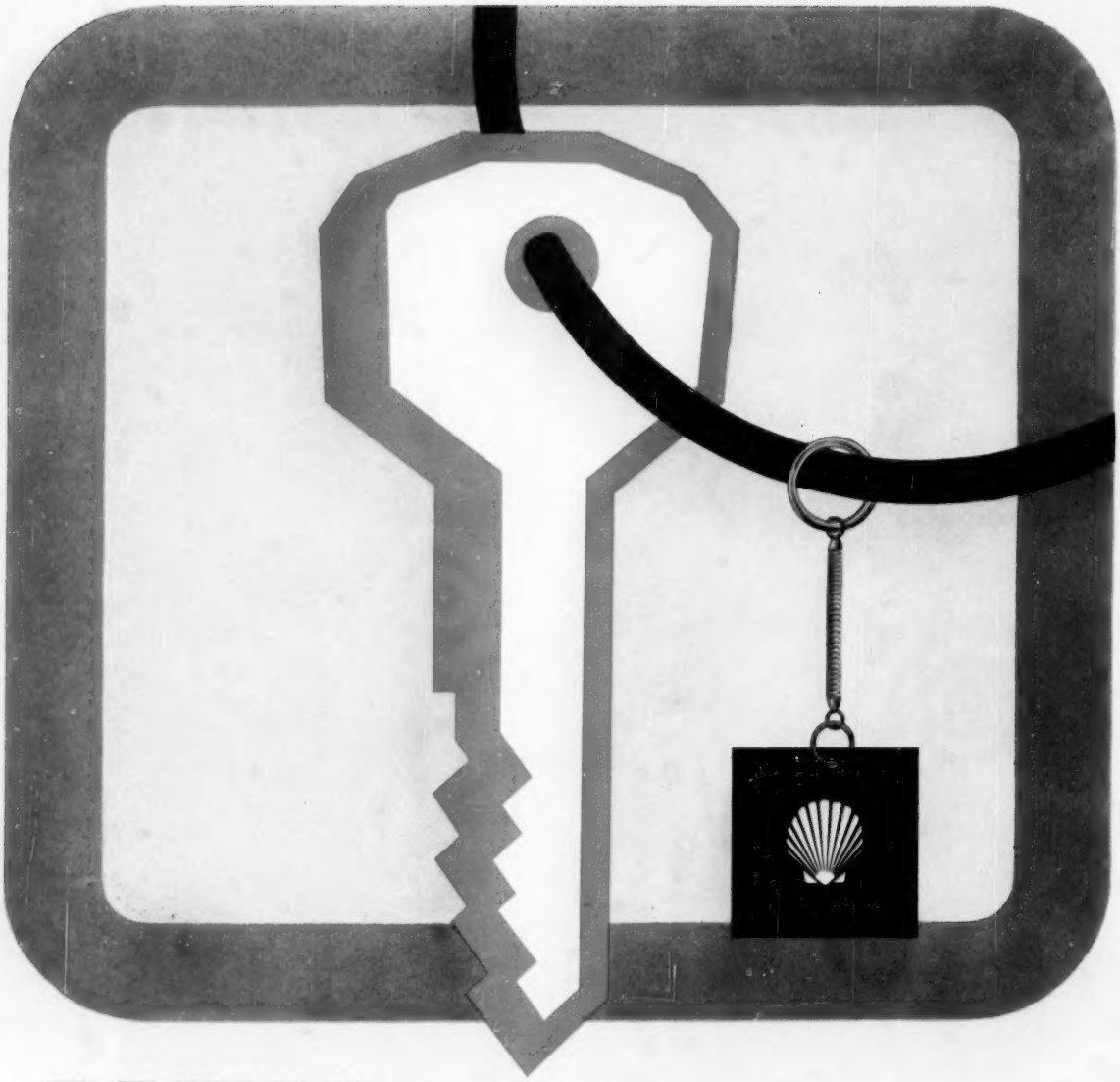

MEK solvent power...

... key to economical, high-performance solvent systems

High-purity methyl ethy' ketone is among the most versatile low-boiling solvents available to the surface coating industry. Its strong solvency for lacquer resins has made it a favorite with formulators.

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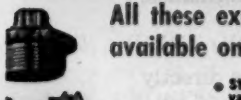

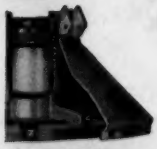

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March 21, 1960 **Chemical Engineering** Vol. 67 No. 6

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

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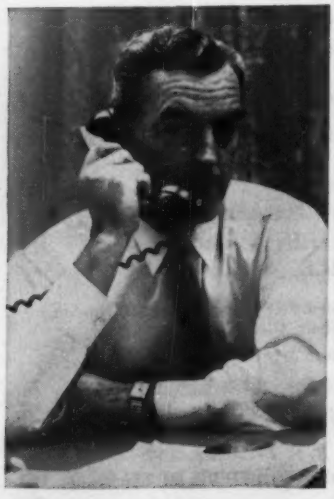

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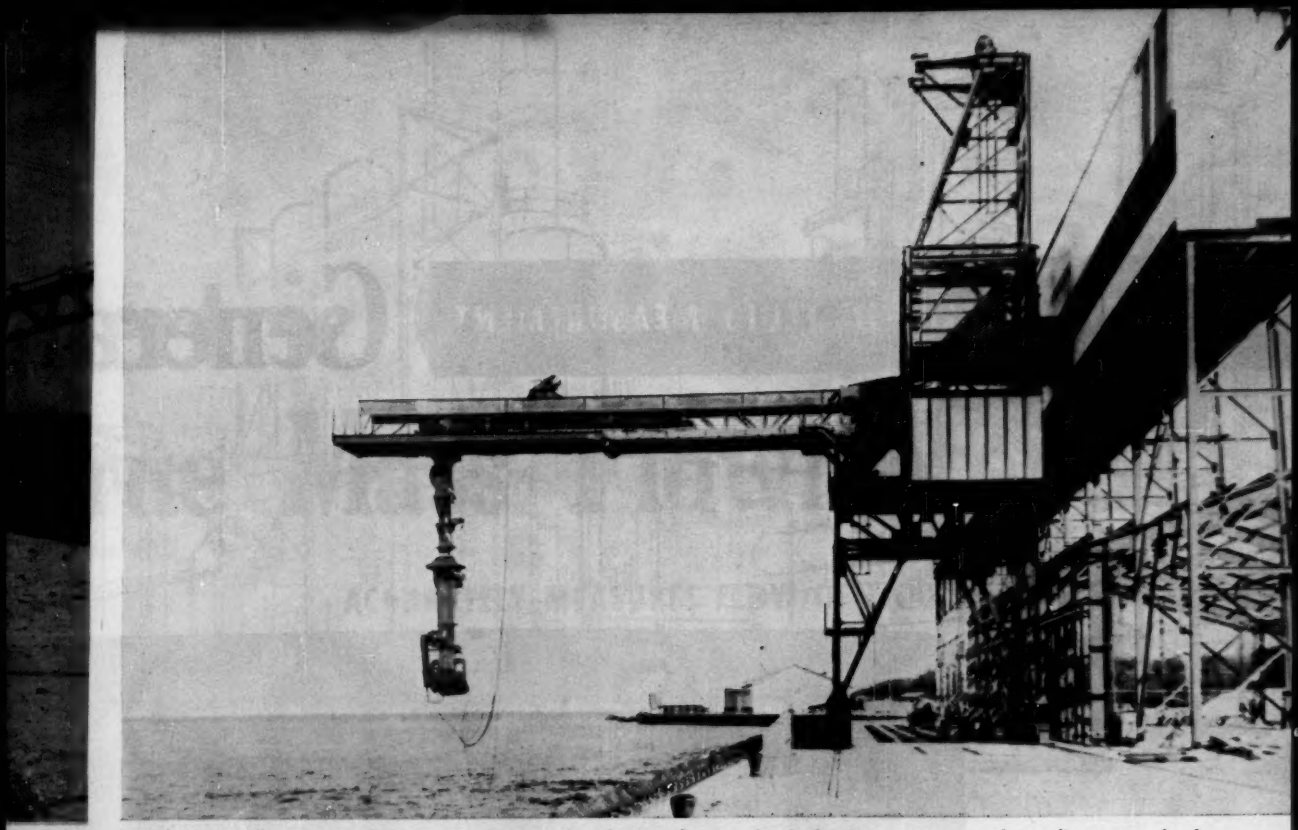

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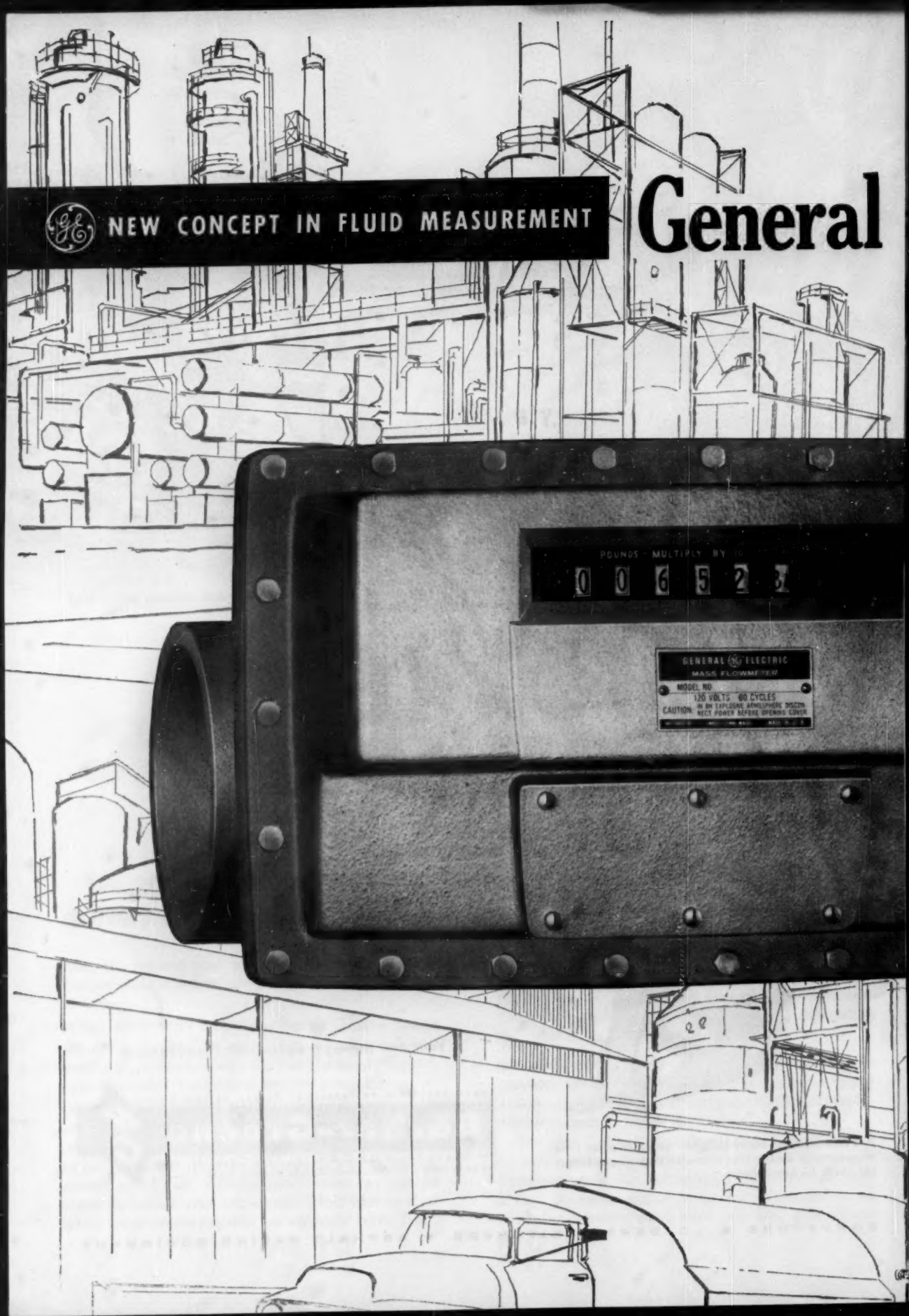
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What's more, the new flowmeter lets you make complete and accurate material balances easily because it operates on a mass measurement principle and gives you your answer *in pounds*. No more measuring liquids in gallons or barrels, gases in cubic feet, then making tedious conversions in order to equate the two. Measurement of both by weight allows direct comparison.

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An outgrowth of General Electric research into mass flow measurement, this new meter has already been proved on such fluids as natural gas, ethylene, Freon, liquid carbon dioxide, naphtha and jet fuel.

For complete sales and service information, contact your nearby General Electric Apparatus Sales Office, or write for bulletin GEA-6925A, Section 599-02, General Electric Company, Schenectady 5, N. Y. On applications in the natural gas industry, contact Black, Sivalls and Bryson, Inc., Kansas City, Missouri.

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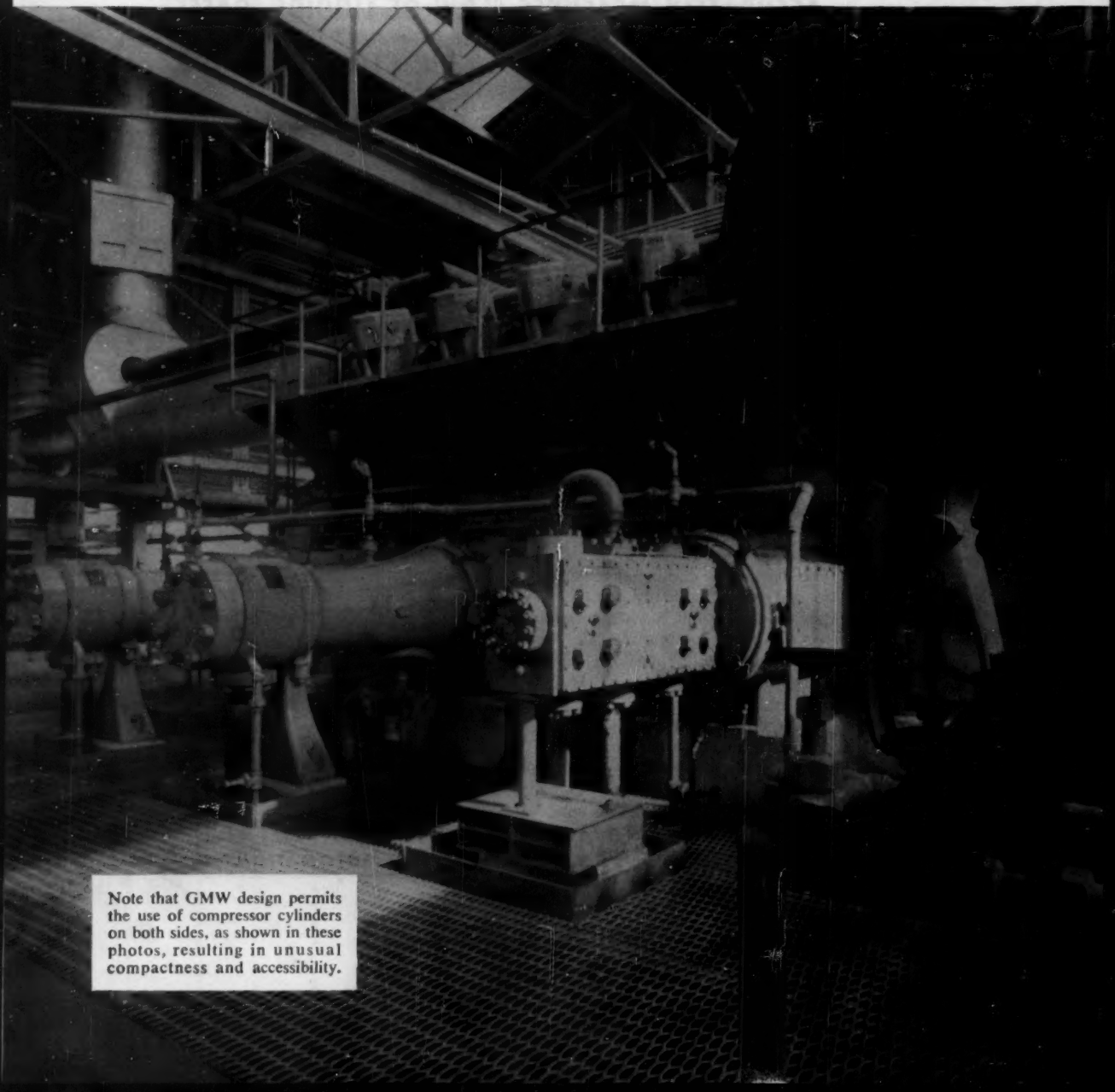
GENERAL ELECTRIC

Report from American Cyanamid, Fortier Plant...

How Cooper-Bessemer gas engine boost synthesis gas for ammonia



Note that GMW design permits the use of compressor cylinders on both sides, as shown in these photos, resulting in unusual compactness and accessibility.

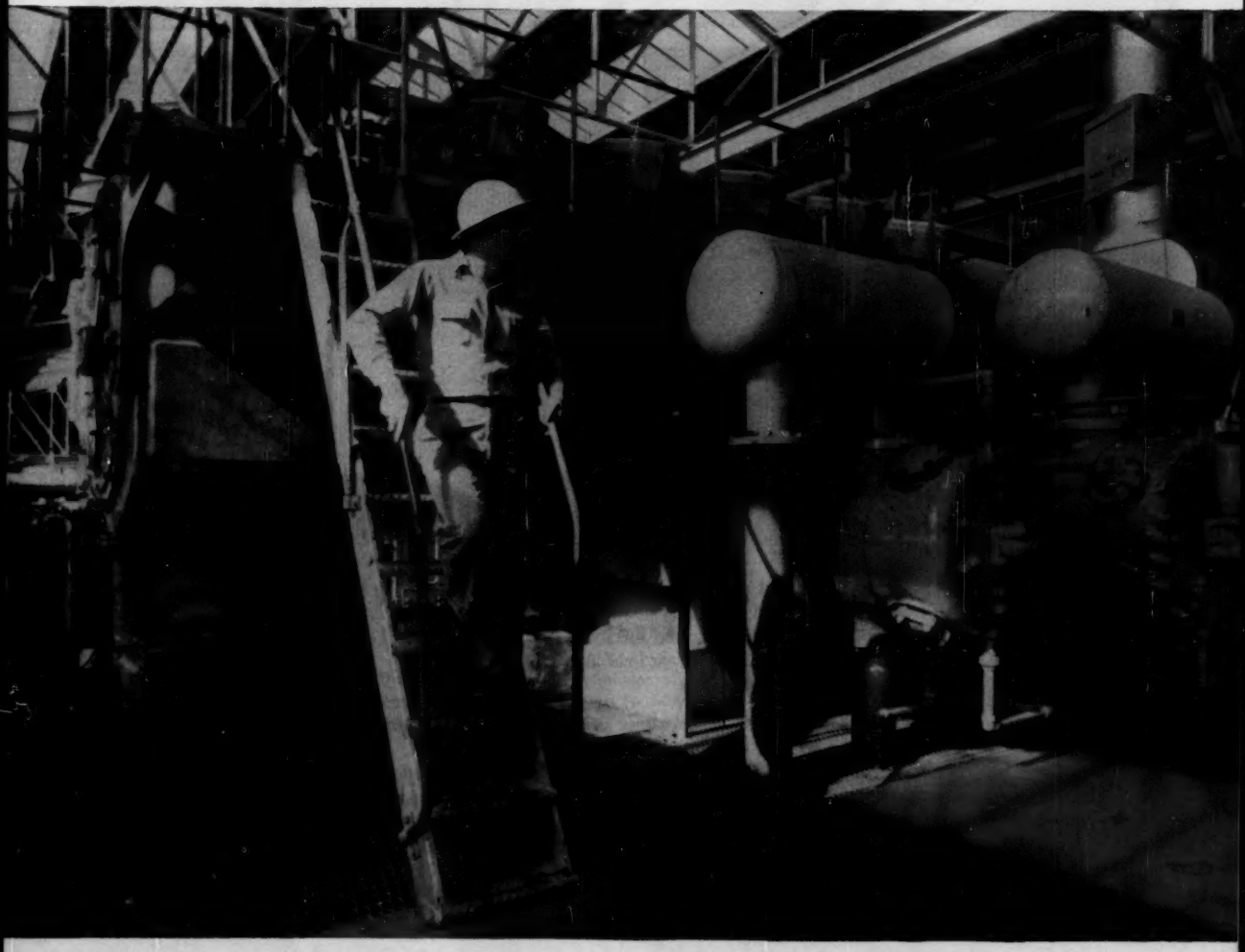
compressors to 5000 psi

These photos show both sides of one of the two Cooper-Bessemer 2500 hp GMW gas engine compressors at the Fortier Plant of American Cyanamid Company, Avondale, Louisiana. In the production of anhydrous ammonia, these 4-stage units compress 6000 cfm of synthesis gas from 60 psi to a discharge of 5000 psi. The left-hand view shows the high pressure cylinders; that on the right shows the low pressure side. The four stages of compression from 60 psi are (1) to 225 psi, (2) to 670 psi, (3) to 1500 psi, (4) to 5000 psi.

The two units have been operating since 1954, 24 hours a day, 340 days a year.

The anhydrous ammonia produced at the Fortier Plant is used by American Cyanamid in the manufacture of Acrylonitrile and is sold to fertilizer plants and other chemical companies.

Find out how Cooper-Bessemer can help *you* plan compression and power facilities. Write for copy of bulletin, "Cooper-Bessemer Equipment for Chemical Plants."



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CONSOLIDATED SAFETY RELIEF VALVES have a special "O" Ring Seat Seal that stops leakage completely

Consolidated Safety Relief Valves are available in both Standard and Balanced Bellows design for extreme corrosive applications.

tightness

The Seal is a resilient ring set in the valve disc. It maintains no-leak tightness by contact with a specially curved seating surface on the valve nozzle, yet does not carry the seat load imposed by the valve spring.

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Standard Consolidated Safety Relief Valves have an eductor tube that removes pressure from the closed bonnet. Only the spring controls valve action. You get guaranteed capacity ratings and highest dependability—absolute protection for personnel and equipment. Additionally, there is the economy of converting the Standard valve to the Balanced Bellows type in your own shop. Get complete details. Write for Bulletin 1940.

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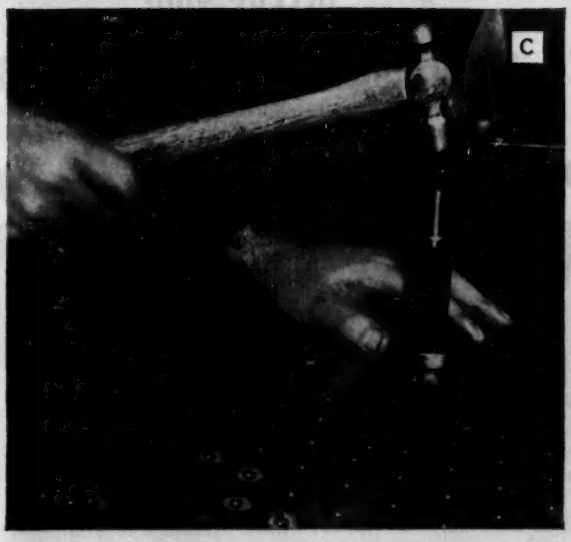

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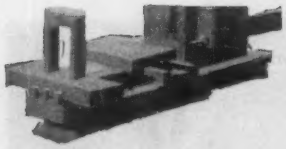

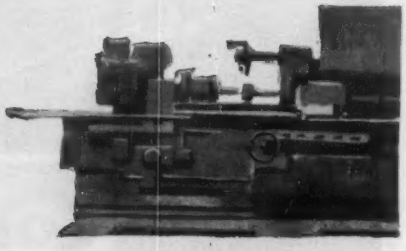

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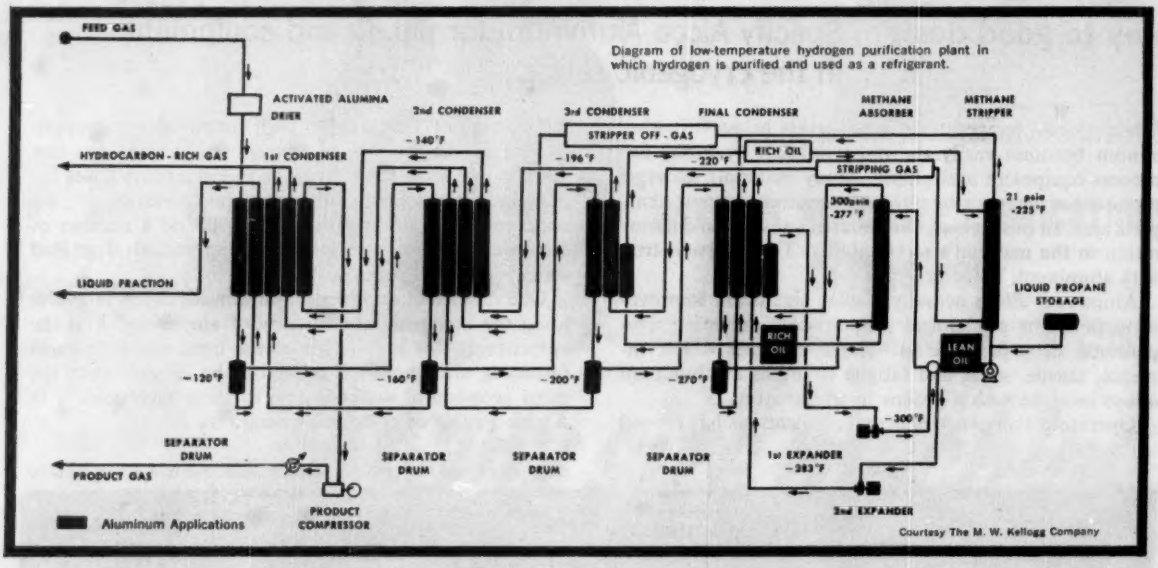


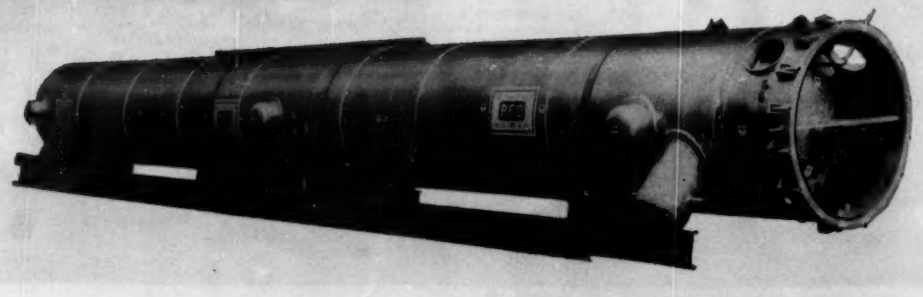
Diagram of low-temperature hydrogen purification plant in which hydrogen is purified and used as a refrigerant.

Courtesy The M. W. Kellogg Company

Because aluminum shows no embrittlement at low temperatures, it enjoys wide use in hydrogen purification plants such as the one shown above.

Aluminum has proved extremely effective for transport piping and tankage in the handling and storage of liquid methane. It is also being used in insulated cargo tanks aboard ship for overseas transport of liquid methane.

Photo courtesy Constock International Methane, Ltd.



This low pressure air separation tower is typical of aluminum equipment now finding broad use in cryogenic operations in the petrochemical field.

Photo courtesy Project Fabrication Corp.

as the temperature goes down

The light weight of aluminum, added to its low temperature performance, makes for easy, effective handling and storage of liquid nitrogen in this 600-liter container fabricated of Alcoa Aluminum Alloy 5154.

In the chart below, you see results of tensile tests on various aluminum alloys at temperatures ranging from 75°F to −423°F. Note that at −320°F tensile strengths average 35-50 per cent higher than at room temperature, yield strengths 15-25 per cent higher. Temperature drop also brings about increases in elongation. And you will notice that there is no undesirable loss in reduction-of-area.

Here, you see evidence of the outstanding low temperature mechanical properties which, coupled with low cost, make aluminum synonymous with efficient, economical design for cryogenic equipment.

Results of Tensile Tests of Some Aluminum Alloys at Subzero Temperatures

Temp., °F	Alloy and Temper	Tensile Strength, psi	Yield Strength,* psi	Elong. in 4D, %	Red. of Area, %	Alloy and Temper	Tensile Strength, psi	Yield Strength,* psi	Elong. in 4D, %	Red. of Area, %	Alloy and Temper	Tensile Strength, psi	Yield Strength,* psi	Elong. in 4D, %	Red. of Area, %
75	3003-0	15,600	6,000	43.0	81	5154-0	35,200	17,100	28.8	66	5356-0	42,100	19,200	30.0	54
— 18		15,600	6,100	44.0	81		35,400	16,600	31.5	72		42,800	19,400	31.5	65
—112		19,000	7,300	45.0	80		36,500	17,200	35.0	73		43,300	19,700	33.5	66
—320		32,300	8,600	48.8	76		51,200	19,600	41.6	60		61,300	22,200	42.5	48
75	3003-H14	23,200	21,500	14.0	54	5154-H32	41,900	31,800	19.0	61	5356-H32	46,300	32,000	24.0	54
— 18		24,000	21,900	15.0	58		43,000	31,900	22.0	68		46,600	32,100	24.0	62
—112		25,600	22,300	18.5	59		44,300	32,000	25.3	68		47,500	32,600	27.0	64
—320		36,600	25,900	32.5	56		62,300	37,400	34.0	53		63,900	37,100	34.0	53
75	3003-H18	30,400	26,700	9.0	34	5154-H34	43,800	34,600	17.0	55	5356-H34	53,200	40,100	16.5	51
— 18		32,000	28,000	8.0	37		44,000	34,600	19.8	62		53,900	40,400	18.5	55
—112		33,400	29,300	11.0	44		45,300	35,400	20.5	64		55,100	41,200	21.0	58
—320		42,800	33,400	23.0	46		55,800	39,800	23.0	58		73,400	47,100	27.5	43
75	5052-0	29,100	14,300	33.2	72	5154-H38	50,400	42,100	14.2	45	5083-0	45,400	21,800	23.0	35
— 18		29,200	14,400	35.8	74		51,000	42,300	16.9	55		46,700	21,000	24.5	39
—112		30,600	14,300	40.8	76		52,200	43,800	19.8	56		47,000	21,200	27.0	47
—320		44,800	16,800	50.0	69		67,400	49,900	24.4	48		62,900	23,800	33.0	38
75	5052-H32	32,200	24,400	21.7	72	5086-0	36,600	16,000	32.0	55	5083-H113	49,800	40,800	15.5	29
— 18		32,900	24,100	22.9	73		36,400	16,600	32.0	60		51,000	38,700	18.0	37
—112		34,800	24,300	26.3	74		37,100	15,600	36.0	62		52,100	42,200	19.0	40
—320		50,700	28,400	37.7	64		52,400	17,000	49.0	52		67,800	48,400	25.0	36
75	5052-H34	38,500	31,200	17.4	58	5086-H32	43,300	31,100	16.0	27	5456-0	50,800	24,100	20.0	26
—18		38,800	30,600	18.8	62		45,200	31,400	18.0	38		49,900	23,700	22.5	34
—112		40,700	31,800	21.0	60		46,900	32,200	23.0	45		49,700	24,000	25.5	41
—320		55,400	37,100	29.7	56		64,400	37,300	30.0	35		66,000	26,800	30.0	33
75	5052-H38	40,100	34,200	16.6	59	5454-H32	42,700	28,900	16.0	30	5456-H321	55,000	38,200	12.0	16
— 18		40,700	33,800	18.3	63		44,100	29,300	19.0	38		57,600	39,600	13.5	19
—112		42,400	34,300	20.6	64		45,500	30,300	22.5	44		57,500	39,200	17.0	27
—320		57,900	39,800	30.9	57		63,200	35,700	31.0	35		74,100	45,400	22.5	21

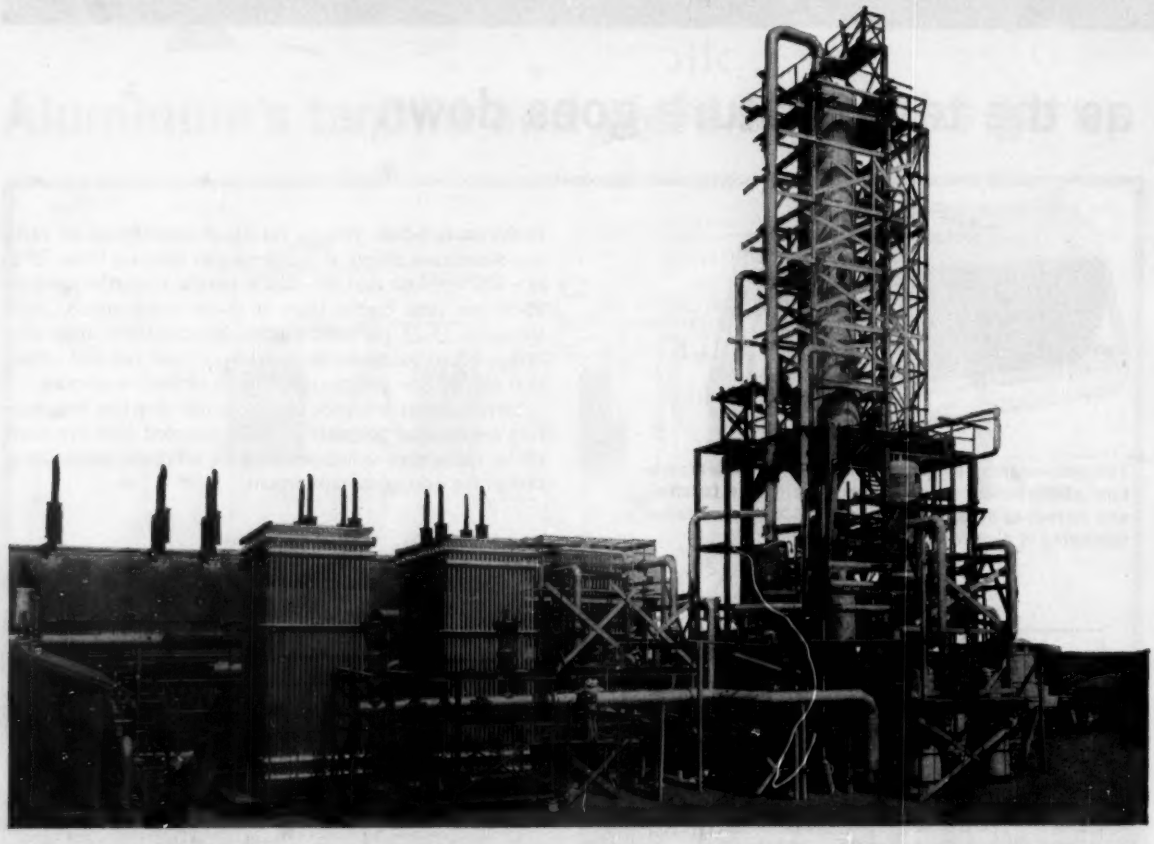
Temp., °F	Alloy and Temper	Tensile Strength, P.S.I.	Yield Strength, P.S.I.	Elongation in 2 in. %	Temp., °F	Alloy and Temper	Tensile Strength, P.S.I.	Yield Strength, P.S.I.	Elongation in 2 in. %
75	5456-H321	57,400	39,500	14.5	75	6061-T6	44,900	40,800	13.8
—320		76,600	47,200	26.8	—320		61,000	48,600	23.3
—423		84,500	51,500	15.6	—423		75,800	55,300	18.3

75	6061-T6	44,300	38,200	19.8	50
— 18		46,100	38,700	19.0	50
—112		48,100	40,200	20.0	50
—320		59,200	45,000	24.6	46

* Offset = 0.

Specimens of special design, courtesy of Lewis Research Center, N.A.S.A.

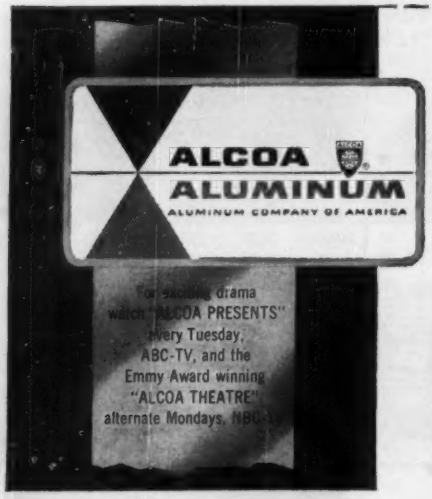
The low temperature ductility of aluminum made it practical to construct this entire oxygen plant of aluminum. The harp-type heat exchangers at the left are dip-brazed assemblies which contain thousands of tiny fins for maximum heat transfer. The structural utility of aluminum may be inferred from the fact that the tower at the right extends some 100 ft.



ALCOA has devoted over 40 years to a careful exploration of the uses for aluminum in the process industries. This experience has developed a substantial body of factual data related to the performance of aluminum. That information is yours for the asking. Simply describe your problem as clearly as possible in a letter to the address indicated on the coupon below. For free copies of available literature, simply fill in and mail this coupon.

In 1960, Alcoa will continue to conduct its annual series of engineering conferences relating to process industries applications of aluminum. Your nearest Alcoa sales office will furnish details.

World wide sales through ALCOA INTERNATIONAL, INC., 230 Park Avenue, New York 17, New York.



Aluminum Company of America, 871-C Alcoa Building, Pittsburgh 19, Pennsylvania.

Please send me the following literature covering Alcoa Aluminum uses in the process industries:

- ☐ 11251 Cryogenic Applications of Alcoa Aluminum
- ☐ 10197 Aluminum Pipe and Fittings
- ☐ 10418 Alcoa Unitrace: Combines Piping and Tracing in One Unit
- ☐ 10270 Alcoa Utilitube
- ☐ 10460 Process Industries Applications of Alcoa Aluminum
- ☐ 10508 Cleaning and Maintenance
- ☐ 20849 Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres
- ☐ 20265 Have You Tried Aluminum in Your Refinery?
- ☐ 20935 Designing to Prevent Corrosion
- ☐ GL-86C Unfired Pressure Vessels of Aluminum Alloys
- ☐ 20437 Aluminum Alloy Heat Exchangers in the Process Industries
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- ☐ 21090 Resistance of Aluminum Alloys to Fresh Waters
- ☐ 19416 Brazing Alcoa Aluminum
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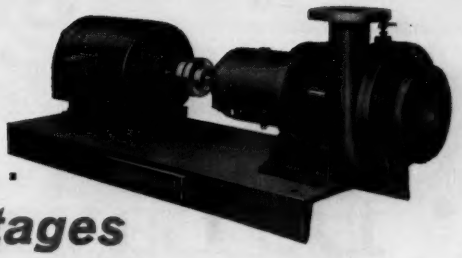
cradle-mounted pumps for any application . . .

all with these basic advantages



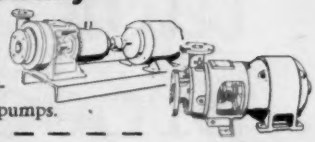
Simplicity of design, rugged construction, careful material selection and expert workmanship enable Ingersoll-Rand cradle-mounted pumps to meet the highest performance standards, year after year, with minimum attention or maintenance.

Built in sizes through 100 horsepower, deliveries range to 3200 gallons per minute, heads to 525 feet. Single or two-stage models available with threaded or flanged intake and discharge connection.

Call on your nearest Ingersoll-Rand pump specialist to help with your liquid-moving problems. There are standard or engineered units to suit any requirements.

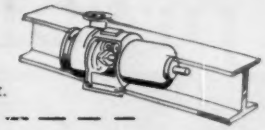
interchangeability

— hydraulically and physically, the pump ends are interchangeable with I-R Motorpumps.



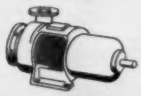
maximum strength

— barrel type construction gives greatest rigidity and perfect alignment.



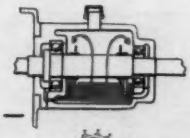
accessibility

— large side openings provide easy access to stuffing box.



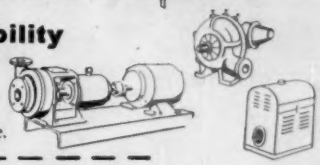
effective bearing lubrication

— ring-lubricated bearings easily handle radial and axial loads.



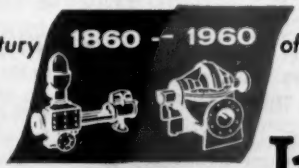
driver flexibility

— permits use of motor, turbine, engine or belt drive.

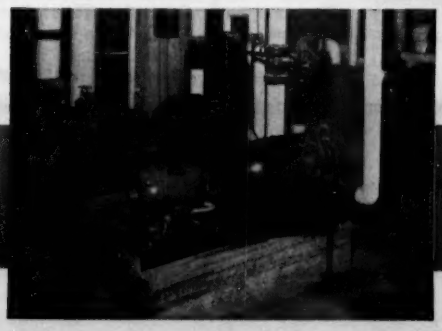


a century **1860 -- 1960** *of pump progress*

from the leading manufacturer . . .



A turbine-driven cradle-mounted pump and a motor-driven standby in a manufacturing plant power house.



Ingersoll-Rand

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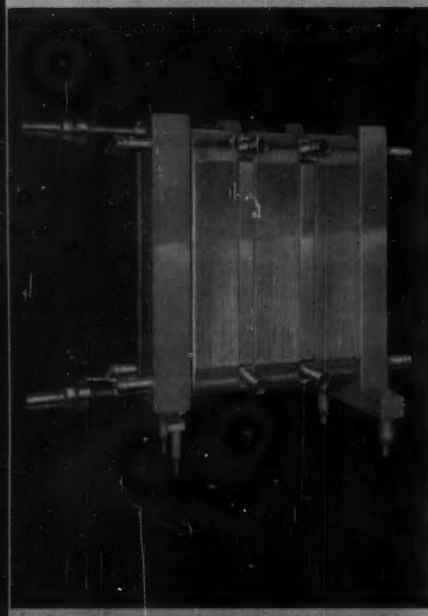
OTHER I-R PUMPS AVAILABLE

Motorpumps | Self-priming pumps | Horizontally split pumps

De Laval tackles process problems

...economically!



Hic!

Many barrels of wine have barreled through our sturdy Plate Heat Exchangers. So, too, have vast quantities of orange juice, milk and beer. Between the stainless steel plates, pasteurization temperatures are quickly reached and closely held. Remarkably high exchange efficiencies are economically evident in heating, cooling and regenerative sections. High turbulence, even at low velocities, is assured by the corrugated plates of De Laval Plate Heat Exchangers. Differentials as low as 5°F in the exchange streams are practical.

Food applications have been a "natural" for the sanitary construction of these exchangers. But their performance efficiency and maintenance economy is earning more spots in rough industrial service. The reasons are simple and sound:

- Sturdy stainless steel gives the insurance of long, dependable, maintenance-free operation.
- Capacity is easily increased any time. Just add plates.
- Arrange for dual or triple-section operation by simply adding headers.
- Clean-in-place, as required; or open in minutes for full exposure of plate surfaces.
- Typical heat transfer coefficients are in the range of 600-750 Btu/hr-ft²-°F — often over 900!
- Full capacity range—to 1600 square feet of exchange area.
- The most compact heat exchange system available. Stands freely in small floor area and needs only piping connections.

For Further Information Write To

DE LAVAL

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York
5724 N. Pulaski, Chicago 46, Illinois

DE LAVAL PACIFIC COMPANY, Dept.
201 E. Millbrae Avenue, Millbrae, Calif.

CENTRIFUGES
PLATE HEAT EXCHANGERS
VIBRATING SCREENS
COMPLETE PROCESSES

Shake a Lot, Toss a Little ...Shake a Little, Toss a Lot

In seiving by hand, you intuitively adjust the amount and type of shaking and tossing to get optimum separation. Now this same full range of controlled motion is available in a high-capacity screen separator. Simply adjust three controls to obtain a predictable "3-D" screening action ranging from gentle nudging of easily-damaged products, to turbulent, intense exposure of powders, granules, or slurries to screen for rapid, efficient separations.

A review of the De Laval Syncro-Matic features reveals why it is rapidly finding use in such applications as:

- Scalping of liquid suspensions prior to centrifugal separation.
- Grading of fruits, nuts and diced vegetables.
- Thickening of wood pulp slurry.
- Classification of resin molding powders.
- Removal of spent grain in fermentation.
- Removal of fines from crystals.
- Separation of fibers from pulped food.

In all cases, the *particular* optimum combination of screening motion was determined by simple adjustment of control dials. When the De Laval Synchro-Matic is used for multiple separation processes, resetting of the motion controls is done in minutes. Positive-control action assures constant screening action regardless of load conditions.

The full versatility and effectiveness of the Syncro-Matic can be detailed to you by a De Laval representative. Drop us a line to have him call, but meanwhile, think about:

- Single, double or triple decks of easily-replaceable screens.
- "Infinite" range of calibrated control in *three* directions.
- Light, stainless steel construction.
- Quiet and almost vibrationless operation with few moving parts.

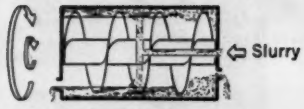
WATCH IT! YOUR NEURONS ARE STIFFENING!

"Electronic brains are not victims of habit. We humans, unfortunately, are. Life is easier when 'thinking' is channeled through well-worn familiar paths. That way, our conclusions seldom surprise us. And, like the hardening of our arteries, the neurons of our mind 'stiffen.'

"Do this. Be a **computer** for a day! Feed in the surprisingly **new** information on today's process equipment. Program it to point up the improvements **or complete changes** actually possible in your process. Naturally, we hope these limbered-up neurons will evaluate the information given here."

Fred Wheelwright, Industrial Sales Manager

2000G Centrifuge "Lies Down" to Tackle Continuous Separation of Slurries and Suspensions



Cylindrical Bowl

Conical Bowl

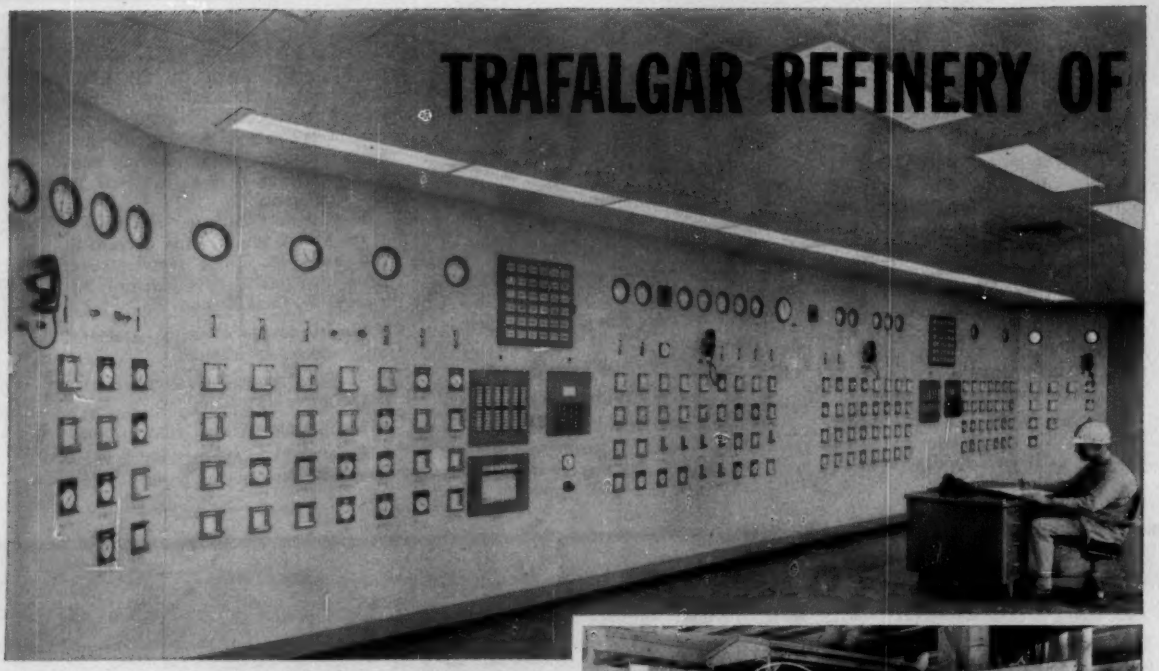
Minute solids particles to ½" lumps are instantly separated from liquid in a "2000G" environment. That's the centrifugal force generated by the De Laval "NX De-Sludger"—a hollow-bowl centrifuge that operates on a horizontal plane.

The continuous separation is effected by a screw conveyor which revolves slowly relative to the bowl wall, pushing solids to discharge ports at one end while the clarified liquid is discharged at the other.

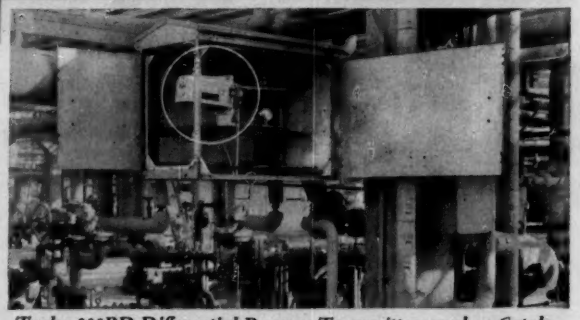
Materials ranging from crushed pulps to mineral slurries are handled with equal ease by the De Laval "NX De-Sludger." Typical applications include "roughing" separation of liquid prior to conventional centrifuging, and controlled de-watering of slurries prior to further processing.

Relatively new, the De Laval "NX De-Sludgers" are replacing batch-settling and screening operations to give more effective trouble-free continuous separation. Design features include choice of cylindrical, conical or combination bowl types, adjustment of bowl liquid level and conveyor speed.

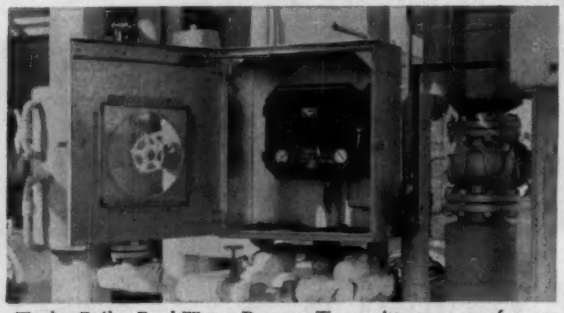
Would exposure to 2000G's plus continuous discharge solve a separation or concentration problem for you? We'll be happy to discuss it at no obligation. Just write!



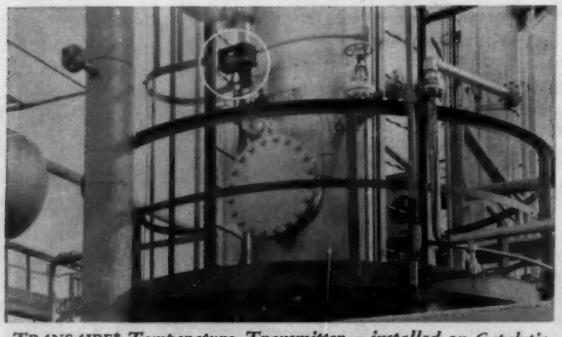
Centralized Taylor Control Panel for the four main process units at Trafalgar: (1) Crude Fractionation, (2) Catalytic Cracking, (3) Gas Plant, (4) Catalytic Reforming.



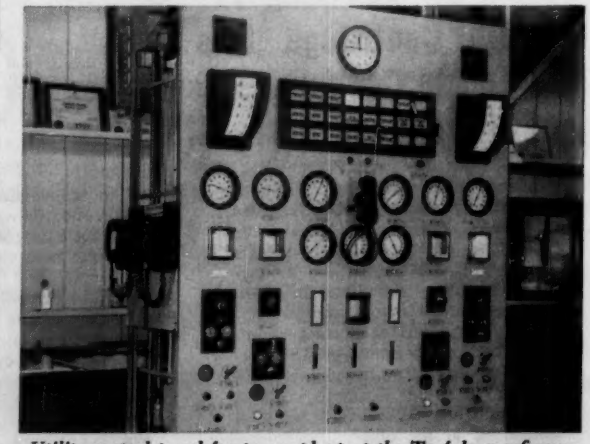
Taylor 333RD Differential Pressure Transmitters used on Catalytic Gasoline Splitter Feed.



Taylor Boiler Feed Water Pressure Transmitters — one of many applications.



TRANSAIRE Temperature Transmitter — installed on Catalytic Gasoline Splitter column bottoms.*



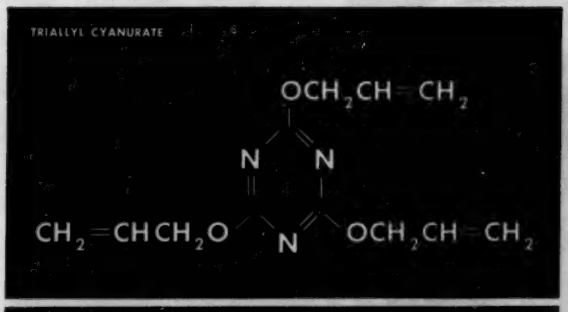
Utility control panel for power plant at the Trafalgar refinery.

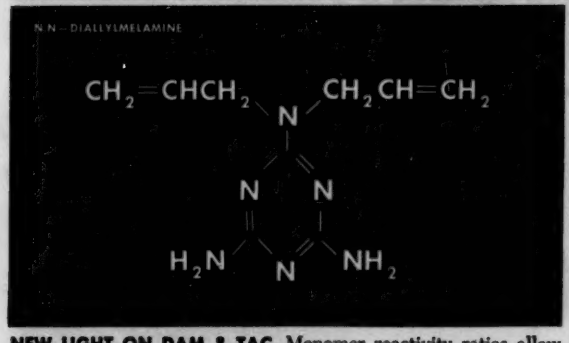
*Reg. U.S. Pat. Off.

Taylor Instruments

CHEMISTRY SERVES A QUEEN. North Carolina's beauty queen wore a formal presentation gown of dazzling white—and Cyanamid is proud that its textile brightener, CALCOFLUOR® White ST, made it that way. The cloth was Cone Mills' "Lurvel," a fine, velvety cotton, velour-type fabric. The gown itself was part of an "all North Carolina wardrobe" produced through the joint efforts of the state's leading designers, manufacturers and retailers. As many textile men know, Calcofluor White brighteners, easily applied during normal textile processing, add exceptional brilliance to whites and pastels—brighten the sales potential of many products.

(Dyes Department)





NEW LIGHT ON DAM & TAC. Monomer reactivity ratios allow predictions of the probable composition of copolymers in terms of the monomers originally present. A data sheet—just published by Cyanamid—sheds new light on the reactivity of triallyl cyanurate and diallylmelamine. There is also data on the actual composition which might be expected in certain polymer systems as well as typical copolymerization and prepolymerization techniques. Write for your copy.

(Market Development Department)

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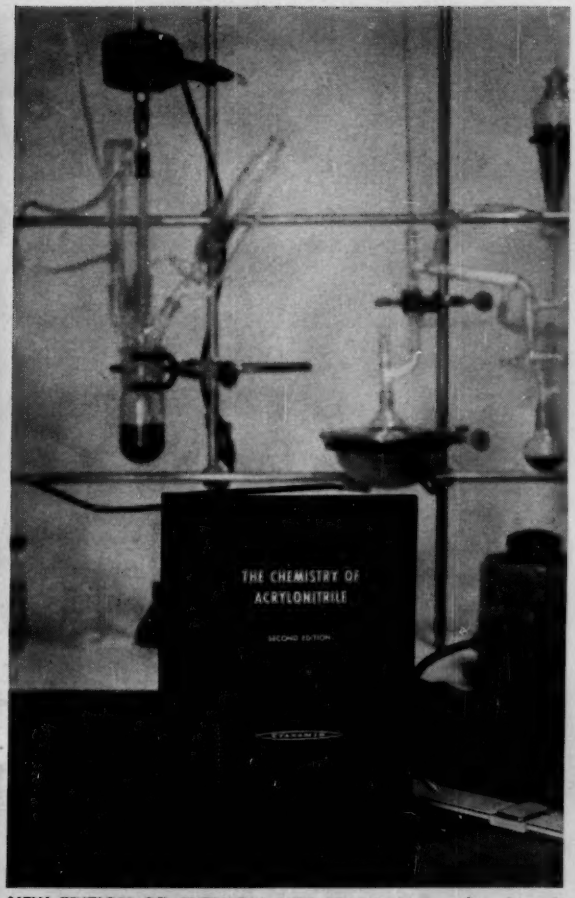

NEW EDITION OF CHEMICAL BEST-SELLER. A second, enlarged edition of Cyanamid's definitive "CHEMISTRY OF ACRYLONITRILE" is now available. Because acrylonitrile has grown so rapidly in importance as an industrial chemical, Cyanamid has expanded and revised the book to encompass latest developments. These include new applications in plastics and surface coatings, synthetic fibers, and as a modifier for natural polymers. A major new section of the book contains tables of reaction conditions, yields, and literature references for many known reactions of acrylonitrile.

(Petrochemicals Department)

For further information on products in this advertisement wire, phone—or mail this coupon to:

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- ☐ CALCOFLUOR® WHITE ST
- ☐ DAM TAC DATA SHEET
- ☐ THE "CHEMISTRY OF ACRYLONITRILE"

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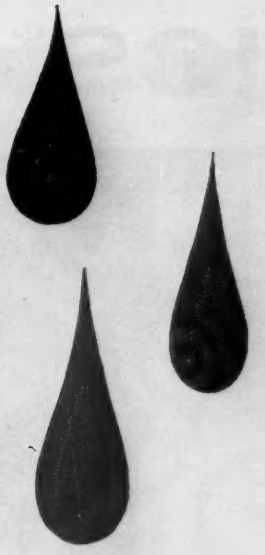

. . . that didn't cause damage . . .

thanks to CFC Filters

This Honeycomb Filter Tube trapped damaging micro-contaminants *before* they could cause costly injury to machines, processing equipment or products.

CFC Filters reduce maintenance costs, protect valuable equipment, improve product quality . . . by providing continuous micro-clarity for chemicals, gases, oils and water in many and varied operations.

At no obligation, a qualified CFC Filtration Engineer will survey your plant and recommend micro-filtration wherever it will save you money. Write Dept. CE.

Filter out high costs . . .  ***with CFC Filters***

CFC

COMMERCIAL FILTERS CORPORATION

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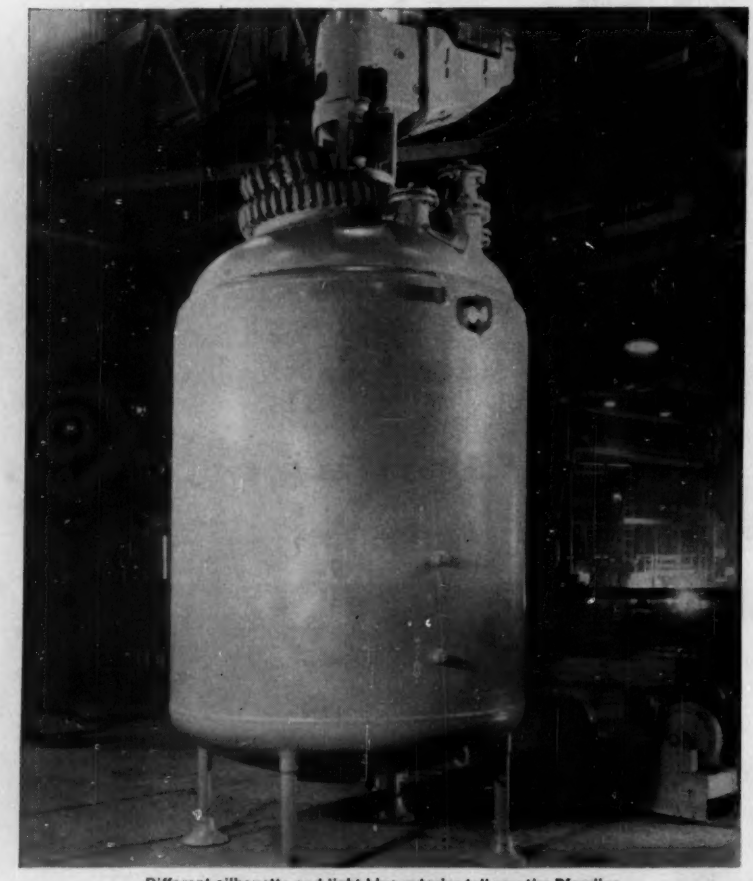
MELROSE 76, MASSACHUSETTS

PLANTS IN MELROSE, MASS. AND LEBANON, IND.

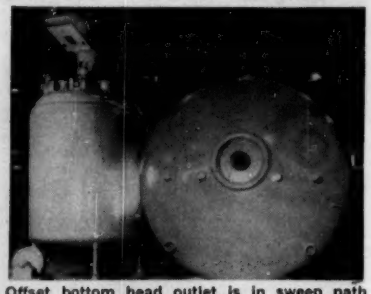
FLUIDICS* AT WORK



Different silhouette and light-blue exterior tell you the Pfaudler "RA" Series Glasteel Reactor is new. Unit shown has BH drive.

TW drive, one of two new drives, provides increased stability for agitator shaft. Runs very quietly.

"Mirror image" provides like-size nozzles on each half of top head. Facilitates piping.



Offset bottom head outlet is in sweep path of agitator and in line with top head manhole.

NEW from top to bottom . . . Pfaudler "RA" Series Reactors

The old "Pfaudlers" (R Series) that you're so familiar with are passing from the scene.

In their place, we now offer you the all new "RA" Series Glasteel Reactors with many significant design improvements.

Two New Drives. Starting at the top you'll find the TW drive on the 300 through 1000 gallon reactors for power requirements to 15 H.P. The BH drive takes over on the 1500 gallon and larger sizes for power requirements to 60 H.P.

Both drive designs are compact, easily installed and maintained. Very quiet, too—a difference that's appreciated when operating a full line of reactors.

Mirror Image Top Head. Next, note the equal number of nozzles on each half of the top head, placed symmetrically for ample freedom in piping. For example, you can feed two reactors from a single tee—one to the left, one to the right.

And since there are no cumbersome drive supports, you have convenient access to manhole, observation window, nozzles, drives, baffles, dip pipe and mechanical seal.

Offset Drain. Off the bottom head you get fast drainage, since the outlet has been offset from center to a position in the direct sweep-path of the agitator. Also, the outlet is in line with the top head manhole for convenient inspection.

Corrosion Resistance. Of course, inside there's Glasteel 59. Excellent resistance to all acids (except HF) to 350° F. and on to 450° F., depending on concentration. Mild alkalies at moderate temperatures are also permissible. Thermal shock resistance is 30% over the "R" series. At a vessel temperature of 250° F. your recommended safe temperature differential is now 260° F. Abrasion resistance has also been increased by 20%. Glasteel 59 is smooth—resists build-up of sticky products. As a result, you have high heat-transfer rates, increased product yield, fewer shutdowns for cleaning, and much longer service life.

Stock Delivery. Standard "RA" Series Reactors range in size from 300 to 4000 gallons. The 500, 750, 1000 and 2000 gallon vessels, fully assembled with standard drives and agitation, are pre-stocked for *two-week* delivery from receipt of your order.

Write for Specifications. New Bulletin No. 988 is now available. For your copy, write to our Pfaudler Division, Dept. CE-30, Rochester 3, New York.

Does a WIPED FILM evaporator fit your process?

Yes, if you evaporate products that are

(1) heat sensitive, or
(2) highly viscous, or
(3) low in thermal conductivity.

What makes the Pfaudler Wiped Film Evaporator so well suited is the *mechanically wiped* evaporating surface.

It works like this: Centrifugal force of an internal rotor (pictured at the right) holds four free-floating wipers in contact with the evaporator wall. These wipers spread your product out over the entire evaporating surface in a *thin, uniform* film. Slots in each wiper prevent product "curl" forward of the wipers and accelerate product movement down the wall.

Since the heated wall is kept completely wet, you are sure of maximum heat transfer —a very important consideration with viscous and heat-sensitive materials, or those with low thermal conductivity.

Test, anyone? In our Test Center we maintain a 4-square-foot Wiped Film Evaporator for product evaluation studies.

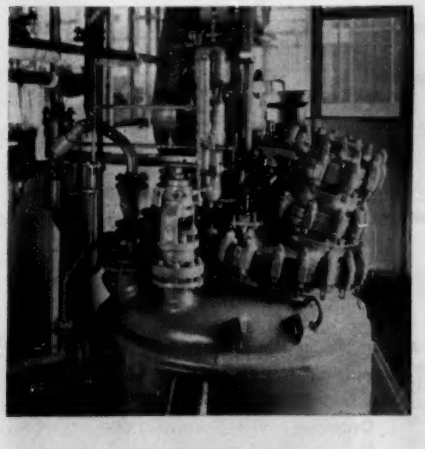
Production units offer 4 to 100 square feet of evaporating areas. (That's a 50-square-foot one being assembled in the picture.)

We'd be happy to send you detailed specifications or provide further information about the test program.

"By Pfaudler glassed-steel equipment a whole pack of problems got its best solutions."

Literally translated into English from German, this statement sums up nicely the experience of C. F. Boehringer & Soehne GmbH.

Established in 1859 and located in Mannheim-Waldof, Germany, this famed pharmaceutical firm has made many important contributions, particularly in the field of antibiotics.



Naturally, much attention is paid to cleanliness and product purity. So you find whole batteries of Pfaudler reactors at work. No problems with corrosion from processing under acid conditions from pH 7 to pH 4; no problems with operating temperatures from 85 to 120° F; no problems with quick and complete cleaning—since these conditions fall comfortably within the much broader range of corrosives and operating temperatures recommended for Glasteel.

Not only are these reactors *in* use in Germany, they were fabricated *there* by our German subsidiary, Pfaudler-Werke, A. G.

Which leads us to the fact that you can take advantage of our FLUIDICS program almost anywhere in the world. We maintain, along with our German facility, plants in Great Britain (Enamelled Metal Products Corp. Ltd.), Canada (Ideal Welding Co. Ltd.), Mexico (Arteacero-Pfaudler, S. A.), and Japan (Shinko-Pfaudler Co., Ltd.). Of course, many of our products and services flow from our four plants in the U. S. A. So, wherever you are, we'll come to you.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

You can specify Glasteel for these and many other chemicals

Acetic acid	DDT
Aluminum chloride	Ether
Aluminum sulfate	Ethylene glycol
Ammonium thiocyanate	Formaldehyde
Ascorbic acid	Hydrochloric acid
Benzene	Nitric acid
Benzyl chloride	Phenol
Butyl alcohol	Phosphoric acid
Bromine	Phosphorous oxychloride
Caustic soda	Potassium sulfate
Chlorine dioxide	Sodium chlorate
Monochlor-acetic acid	Sulfuric acid
Chloroform	Thionyl chloride

In fact—with any acid (except hydrofluoric) GLASTEEL just keeps working and working, at temperatures up to 350° F., even up to 450° F., depending on concentration. And alkalies at moderate temperatures have no effect on GLASTEEL.

The Pfaudler line of Glasteel process equipment includes reactors, storage tanks, columns, dryer-blenders, pipe, valves and fittings. Specifications are given in our Buyer's Guide, Bulletin No. 980.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

ENGINEERED TEFLON* PRODUCTS
for Chemical Processing

Processors find it good practice to apply Garlock Teflon Packings and Seals against hot, reactive chemicals.

Garlock LATTICE-BRAID† Teflon Packings are strong, long-lasting, chemically inert. Withstand temperatures ranging from −120°F to +500°F. Extremely effective in reducing maintenance . . . require less gland pressure to effect an adequate seal. This results in longer sleeve and packing life, less downtime. Because of the interlocking braid construction, LATTICE-BRAID Packings will hold together far beyond the limits of other packings. Catalog AD-131.

Garlock CHEMISEAL† Mechanical Seals possess greater immunity to corrosion and are more economical than most other designs offered. Easy to handle and install, do not score shafts, engineered for long life. Available in standard sizes to fit all pump shafts ⅞" to 2⅛". Seals against most corrosive media at pressures to 100 p.s.i. at 75°C or 75 p.s.i. at 100°C. Catalog AD-164.

Garlock Teflon-jacketed Gaskets give you the advantage of using Teflon without sacrificing resiliency and deformability . . . particularly important on your glass-lined process equipment, light metal flanges, and glass pipe flanges and fittings. Garlock offers four basic designs—slit envelope, milled envelope, formed shield, double jacket —and a wide selection of filler materials and thicknesses. Catalog AD-154.

Garlock Solid Teflon and Teflon-lined Expansion Joints guard costly piping against sudden pressure surges . . . reduce flange breakage, prevent stress, compensate for misalignment. Solid Teflon Expansion Joints can be used against solvents, acids and caustics to 75 p.s.i. Teflon-lined Expansion Joints are recommended for pressures from 60 p.s.i. to 125 p.s.i. depending on pipe size. Catalog AD-137.

GARLOCK

Discuss the sealing of corrosives with your local Garlock representative—he will be glad to offer suggestions and other application assistance you may need. For prompt service, call him at one of Garlock's 26 offices and warehouses throughout the U.S. and Canada. Or, write The Garlock Packing Company, Palmyra, New York.

Canadian Div.: The Garlock Packing Company of Canada Ltd.

Plastics Div.: United States Gasket Company

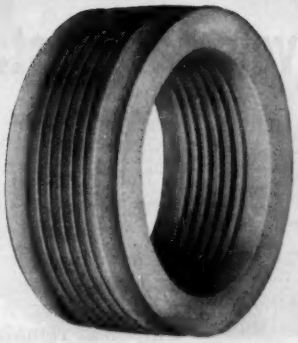
Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products

†Registered Trademark
*DuPont Trademark for TFE Fluorocarbon Resin

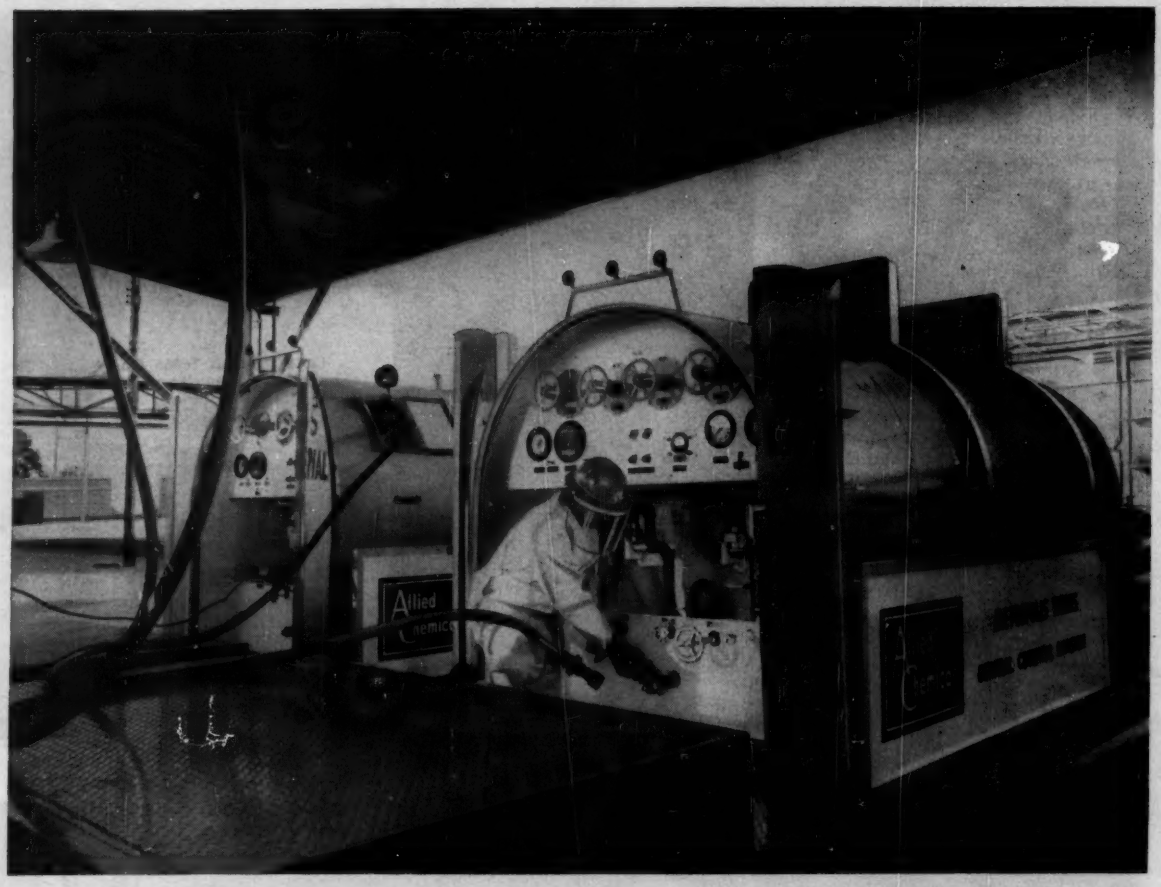
CHEMISEAL Mechanical Seals are in wide service on rotary shafts of equipment like reaction vessels and pumps.

LATTICE-BRAID Teflon Packings are used for rotary and centrifugal shafts, valve stems, and reciprocating rods, rams, plungers.

Solid-Teflon and Teflon-Lined Expansion Joints protect piping from pump, compressor, engine and pressure surges.



Teflon-jacketed Gaskets prevent leakage in glass-lined process equipment, light metal flanges, glass pipe flanges and fittings.



New trailer delivers 2½ tons of liquid fluorine

Corrosive chemical travels safely, stays pure, in Monel

Commercially pure liquid fluorine in bulk is now being shipped thousands of miles. It goes in 2½-ton capacity truck-trailers like those shown above.

The trailers are equipped to cool the fluorine below its boiling point with liquid nitrogen. Units are said to be so efficient that fluorine will remain liquid several weeks even in searing desert weather. Bulk fluorine shipment and the equipment to accomplish it are developments of General Chemical Division, Allied Chemical Corporation.

Inertness of Monel to fluorine safeguards shipments and quality

The inner "business" tank in the trailer is Monel* nickel-copper alloy. The enclosing nitrogen tank is Nickel-containing stainless steel.

Both Monel alloy and the Nickel-containing stainless steel retain excellent ductility and strength well below the sub-zero temperatures of liquid nitrogen. They're well able to withstand unexpected pressures and the shocks of travel.

In tanks made of these alloys the fluorine proceeds tranquilly to its destination. There it can be stored in the same tanks until used.

Monel alloy is also highly resistant to corrosion and to ignition in fluorine at high temperatures since it forms a protective adherent fluoride film. Shipment remains free of contaminating corrosion products.

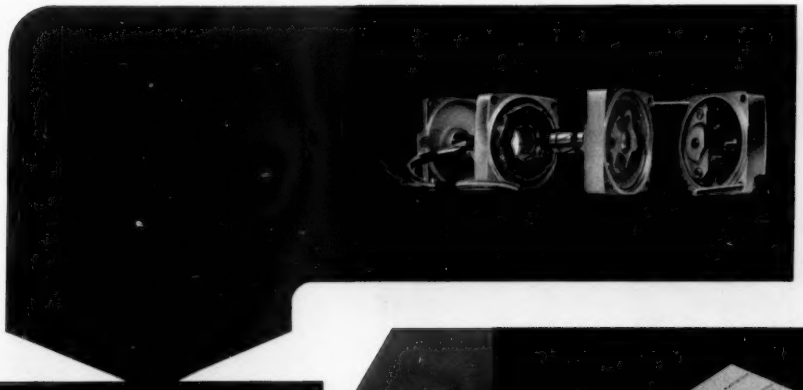
Protect *your* fluorine processing and handling equipment with Inco Alloy Products. A new fluorine booklet, "Handling Fluorine and Fluorine Compounds," goes into detail on fluorine corrosion, suggests means of overcoming it. If you like, we'll send you a copy.

*Inco trademark

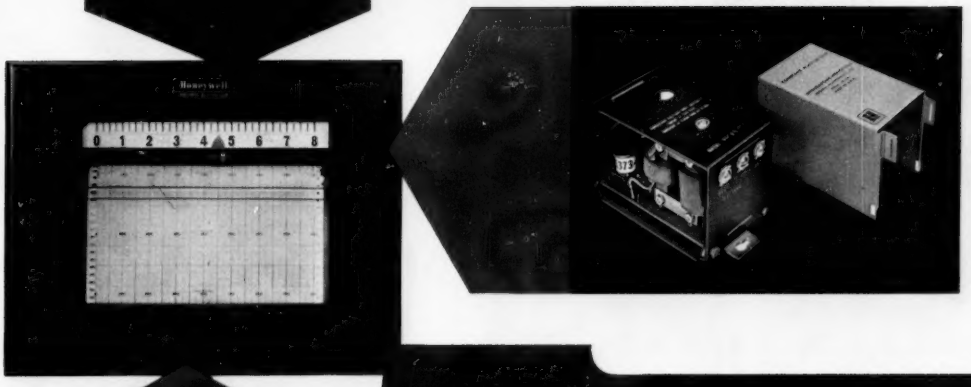
HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

MONEL®

MODULAR DESIGN MAKES 1960 *Electronik* POTENTIOMETERS A GREATER VALUE THAN EVER



BALANCING AND CHART DRIVE MOTORS are sectionalized. Service is simplified because any major part can be replaced in a matter of seconds.



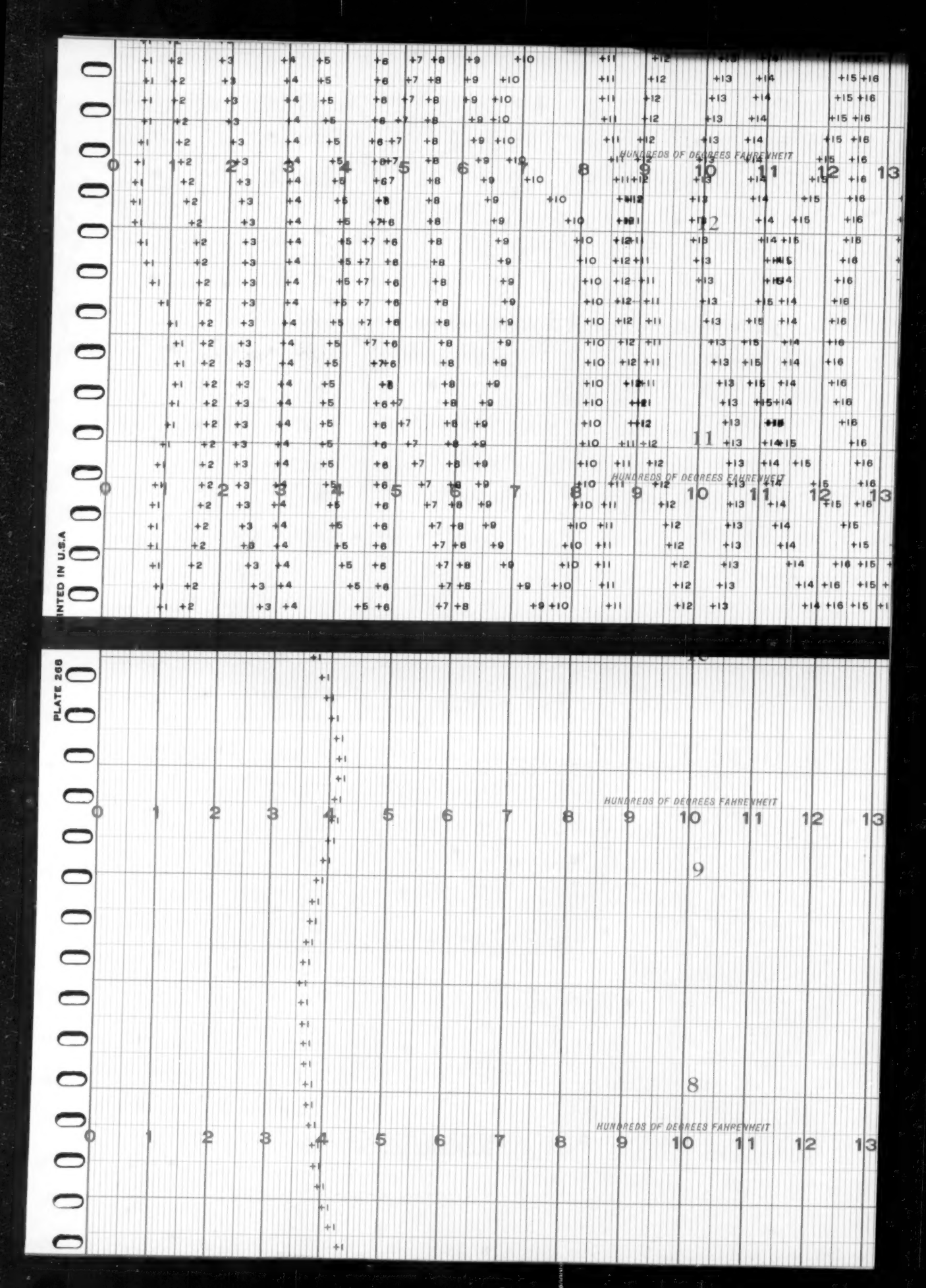
CONSTANT VOLTAGE UNIT* eliminates need for batteries, standard cells, and standardizing mechanisms . . . insuring long life.

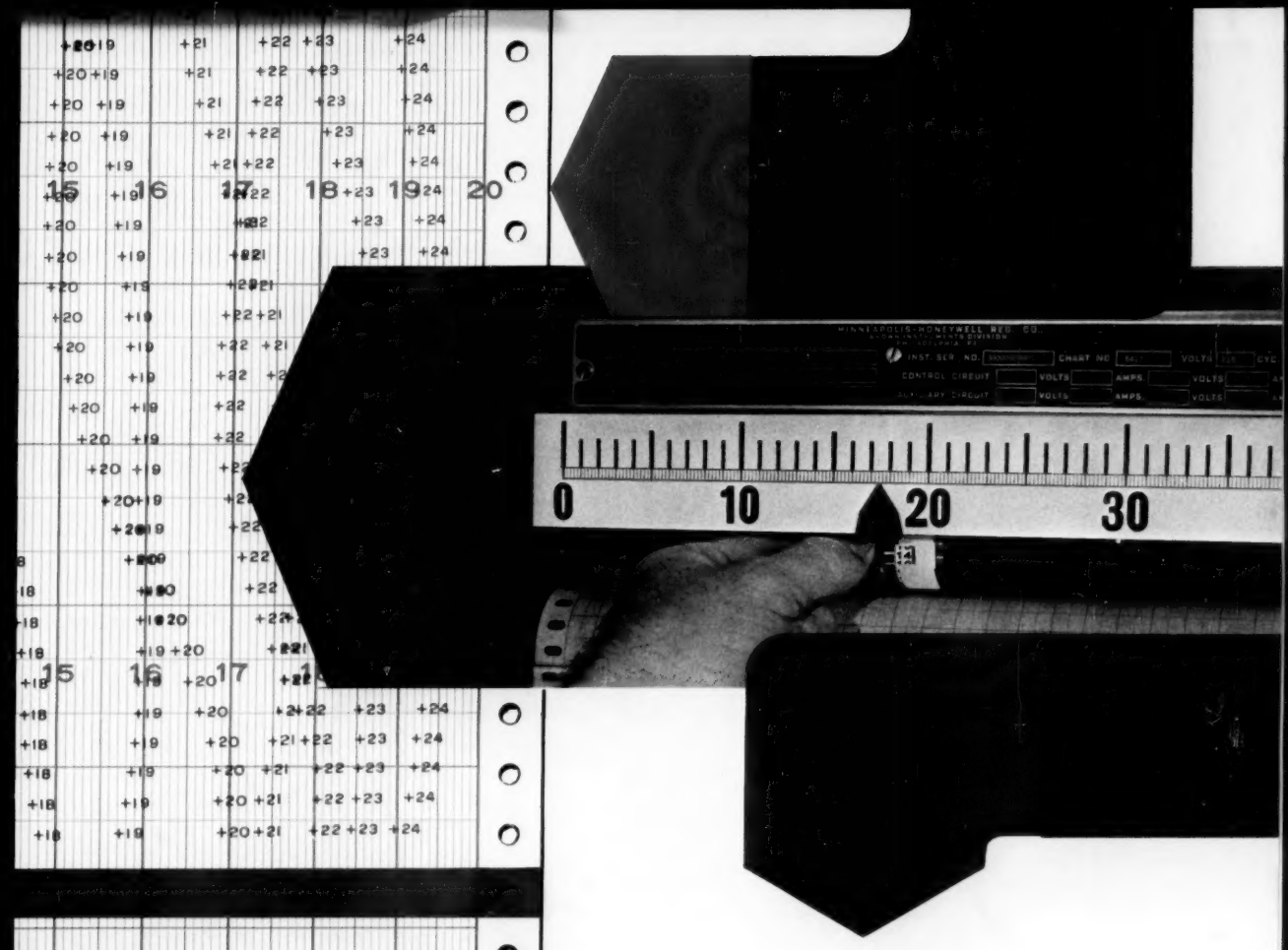
*Zener Diode

COMPARTMENTED MEASURING CIRCUIT UNIT makes range changing easy. Change one screw on a clip connected card of fixed resistors, and the job is done in a matter of seconds.

QUICK-CONNECT AMPLIFIER is easily removed from the instrument by means of a polarized plug.

BUT THIS IS JUST PART OF THE STORY OF THE 1960 LINE OF ELECTRONIK POTENTIOMETERS. LOOK AT THE DRASTIC CHANGES IN THE ELECTRONIK MULTI-RECORD RECORDERS.


HUNDREDS OF DEGREES FAHRENHEIT
HUNDREDS OF DEGREES FAHRENHEIT
HUNDREDS OF DEGREES FAHRENHEIT
HUNDREDS OF DEGREES FAHRENHEIT
PLATE 268
INTED IN U.S.A



Record 2 to 24 points on one instrument with new UNIVERSAL *ElectroniK*

MULTI-RECORD INSTRUMENT

Now, you can record 2,3,4,6,8,10,12,16,20, or 24 points on one ElectroniK Multi-Record Instrument . . . and change the number of points to be recorded in a matter of seconds. It's easy as this: remove a thumb-tight nut and slip off old print wheel . . . and indicator dial. Slip on a new wheel and dial: Replace nut. Plug in the number of points desired, and the job is done.

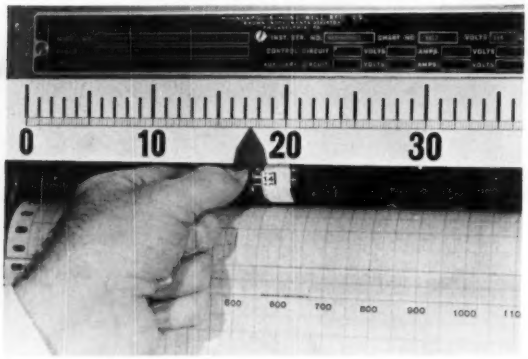
The universal features and modular design of the 1960 line of ElectroniK potentiometers are standard on all multi-record non-control models. Range and compensation changes are quick and easy, too . . . just change the cards.

FROM HONEYWELL... A DIAMOND JUBILEE PARADE OF PRODUCTS

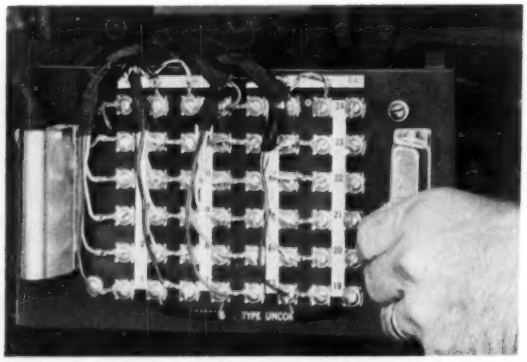
SEE HOW EASY THE 1960 ELECTRONIK MULTI-POINT RECORDERS ARE TO USE...

all it takes with the 1960 *ElectroniK* MULTI-RECORD RECORDERS to change . . .

. . . number of points recorded



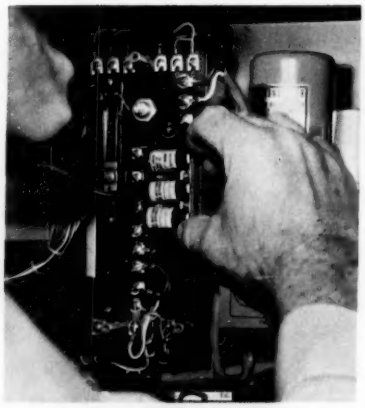
First: remove thumb-tight nut; slip off print wheel and indicator dial. Slip on new wheel and dial and replace nut.

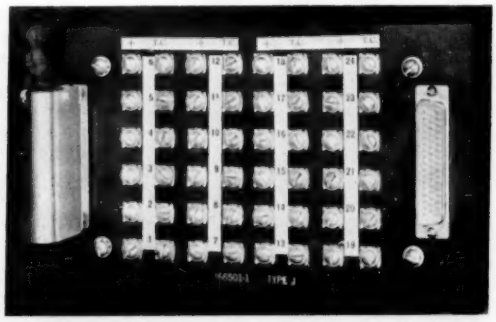


Second: replace one plug-in unit and the instrument is ready to record a different number of points.

The new flexibility and convenience of the 1960 ElectroniK Multi-Record Recorders should interest you. This new design has resulted in substantial manufacturing cost reductions which are reflected in our new price structure. Your nearby Honeywell field engineer has the full details. He's as near as your telephone. Minneapolis-Honeywell, Wayne and Windrim Avenues, Philadelphia 44, Pa.

. . . RANGE—Loosen screws and slide out the range resistor card. Replace with a different card, tighten screws and the job is done quickly and easily.





. . . COMPENSATION—The input terminal board with built-in reference junction comes out by removing one plug. Slide in the new board, replace the screws and plug and the compensation is changed.

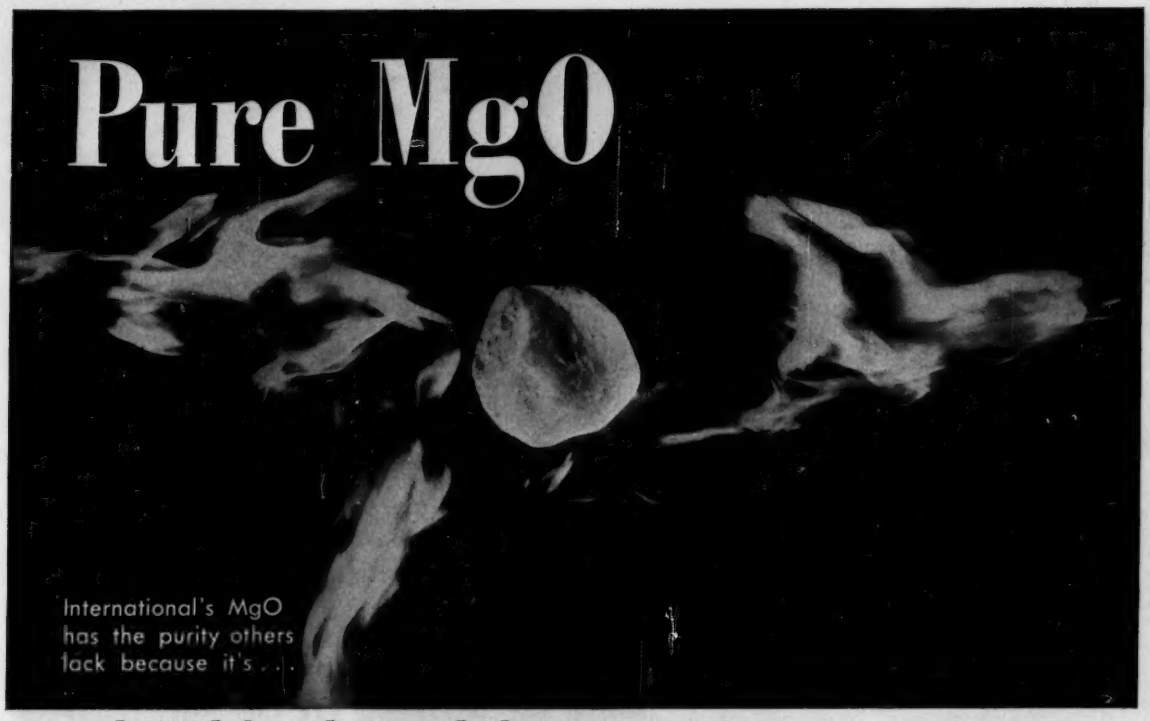
Honeywell

First in Control

SINCE 1885

75th YEAR

PIONEERING THE FUTURE



produced by thermal decomposition

Disappointed with conventional magnesium oxides? Then try International's. *It's the only MgO produced by thermal decomposition.* And the difference is amazing! Electrically furnaced, this MgO has achieved the highest resistivity and refractory properties of any commercially available magnesium oxide.

You'll find International MgO relatively low in cost. Now improved production facilities are geared to produce any quantity you need.

For further details, fill out and mail the coupon . . . you can count on a prompt reply.

Here's how IMC does it!

CONVENTIONAL PROCESSES

Magnesium Chloride $MgCl_2$
(Contained in sea water, well brine, bittern.)
+
Lime CaO
(Contained in dolomite, sea shells, etc.)
↓
Magnesium Hydroxide $Mg(OH)_2$ + heat
↓
Magnesium Oxide MgO

INTERNATIONAL'S UNPARALLELED PROCESS

Magnesium Chloride $MgCl_2$ + heat
↓
Magnesium Oxide MgO + Hydrochloric Acid HCl
↓
heat → MgO

And here's the result!

MgO	99.5%	Cl	0.03	Density .... 75 lbs./cu. ft.
SiO_2	Nil	CaO	0.05	*Low Boron, too, upon request!*
SO_4	0.03	Fe_2O_3	0.05	

INTERNATIONAL MINERALS & CHEMICAL CORPORATION

Administrative Center: Skokie, Ill. • Phone ORchard 6-3000 • 485 Lexington Ave., New York 17 • Midland, Texas

Products for Growth®

IMC

*Trademark

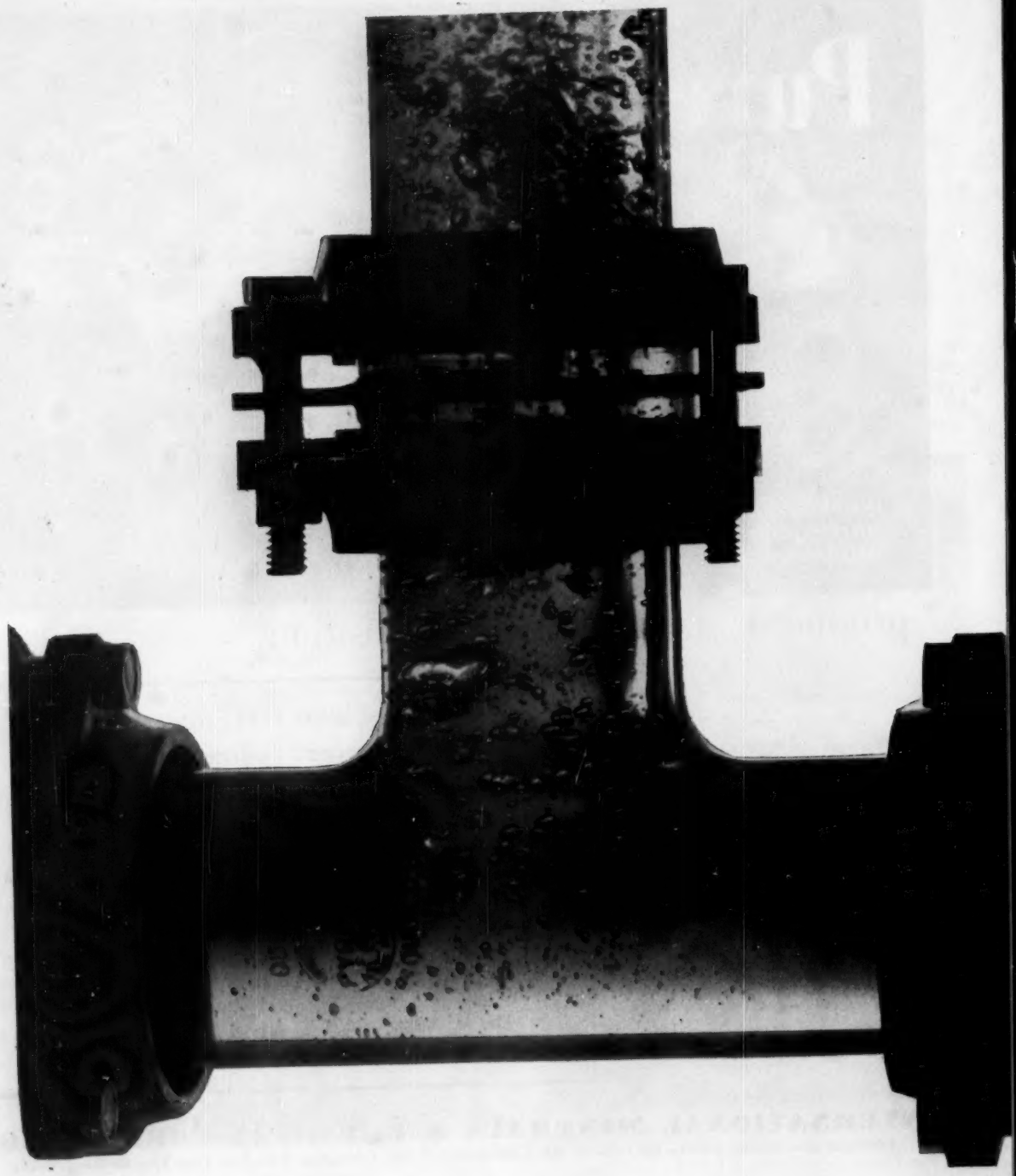
INTERNATIONAL MINERALS & CHEMICAL CORPORATION
POTASH INDUSTRIAL • Skokie, Illinois

This coupon will bring you complete descriptive data and specifications, plus a sample of (check one) . . .

☐ POWDERED MgO ☐ GRANULAR MgO ☐ PELLETIZED MgO

Name .....
Firm .....
Address .....
.....

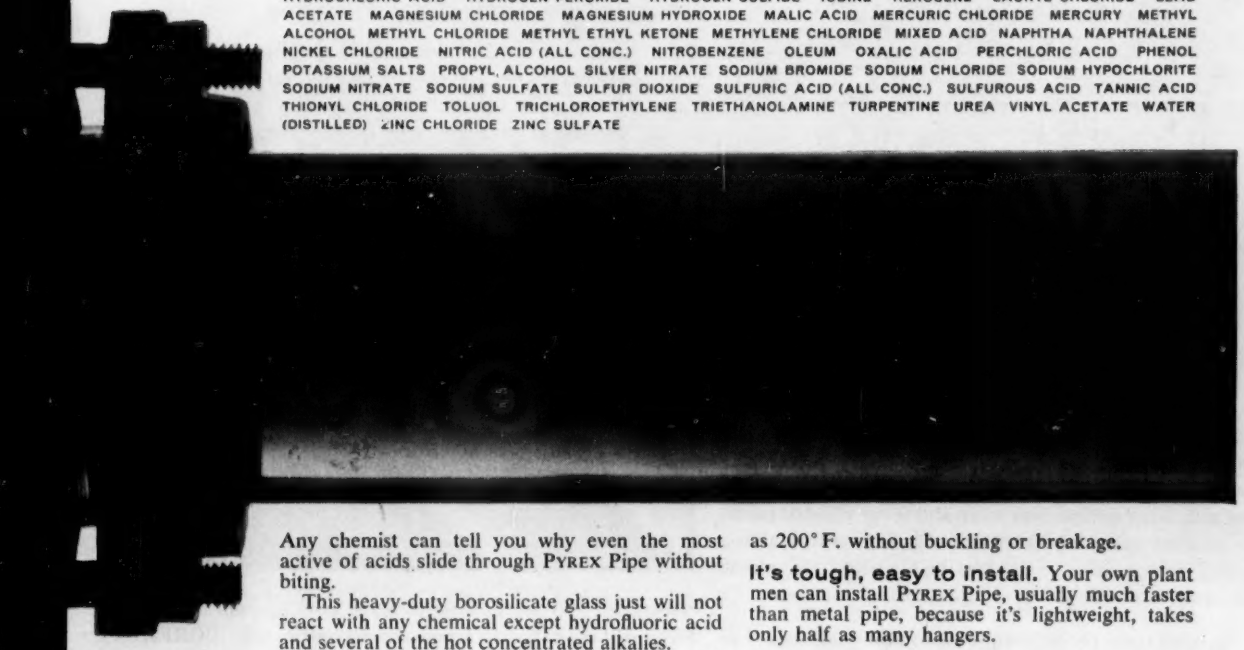
41-59



acids

If you use any of these chemicals, PYREX® Pipe solves your corrosion problems completely

ACETALDEHYDE ACETIC ACID (ALL CONC.) ACETIC ANHYDRIDE ACETONE ACETYL CHLORIDE ADIPIC ACID ALUM AMMONIUM CHLORIDE AMMONIUM NITRATE AMYL CHLORIDE ANILINE AQUA REGIA ARSENIC ACID BARIUM CHLORIDE BENZALDEHYDE BENZENE BENZOIC ACID BORAX BORIC ACID BROMIC ACID BROMINE, LIQUID BROMINE WATER BUTANOL BUTYL ACETATE BUTYRIC ACID CALCIUM HYPOCHLORITE CALCIUM NITRATE CARBONIC ACID CARBON DISULFIDE CARBON TETRACHLORIDE CHLORACETIC ACID CHLORINE GAS, WET, DRY CHLORINE WATER CHLOROBENZENE CHLOROFORM CHLOROSULFONIC ACID CHROMIC ACID CITRIC ACID CRESOL CUPRIC SULFATE CYCLOHEXANOL DIMETHYLAMINE ETHYL ACETATE ETHYL ALCOHOL ETHYL CHLORIDE ETHYL ETHER ETHYLENE BROMIDE FERRIC CHLORIDE (SAT.) FERROUS SULFATE FORMALDEHYDE FURFURAL HYDROBROMIC ACID HYDROCHLORIC ACID HYDROGEN PEROXIDE HYDROGEN SULFIDE IODINE KEROSENE LAURYL CHLORIDE LEAD ACETATE MAGNESIUM CHLORIDE MAGNESIUM HYDROXIDE MALIC ACID MERCURIC CHLORIDE MERCURY METHYL ALCOHOL METHYL CHLORIDE METHYL ETHYL KETONE METHYLENE CHLORIDE MIXED ACID NAPHTHA NAPHTHALENE NICKEL CHLORIDE NITRIC ACID (ALL CONC.) NITROBENZENE OLEUM OXALIC ACID PERCHLORIC ACID PHENOL POTASSIUM SALTS PROPYL ALCOHOL SILVER NITRATE SODIUM BROMIDE SODIUM CHLORIDE SODIUM HYPOCHLORITE SODIUM NITRATE SODIUM SULFATE SULFUR DIOXIDE SULFURIC ACID (ALL CONC.) SULFUROUS ACID TANNIC ACID THIONYL CHLORIDE TOLUOL TRICHLOROETHYLENE TRIETHANOLAMINE TURPENTINE UREA VINYL ACETATE WATER (DISTILLED) ZINC CHLORIDE ZINC SULFATE



Any chemist can tell you why even the most active of acids slide through PYREX Pipe without biting.

This heavy-duty borosilicate glass just will not react with any chemical except hydrofluoric acid and several of the hot concentrated alkalies.

Any accountant could give you another good reason for using PYREX Pipe . . . it actually costs less than many other materials when all installation costs are considered—much less when you include maintenance. If this seems an extreme statement, one of our salesmen can give you specific figures on your plant piping.

You can see through it. You can see inside this pipe, spot trouble immediately, locate it exactly.

You can work hot with it. Run chemicals up to 450° F., even with thermal shocks as high as 200° F. without buckling or breakage.

It's tough, easy to install. Your own plant men can install PYREX Pipe, usually much faster than metal pipe, because it's lightweight, takes only half as many hangers.

Heat exchangers and drainlines, too. We also make a complete line of PYREX brand heat exchangers and laboratory drainlines and fittings.

See our insert in the 1960 Chemical Engineering Catalog. For complete information, write to the address below for bulletins, or contact your Corning salesman.

CORNING GLASS WORKS
1 Crystal St., Corning, N.Y.
CORNING MEANS RESEARCH IN GLASS

3M COMPANY CHEMICALS THE RAW MATERIALS OF PROGRESS

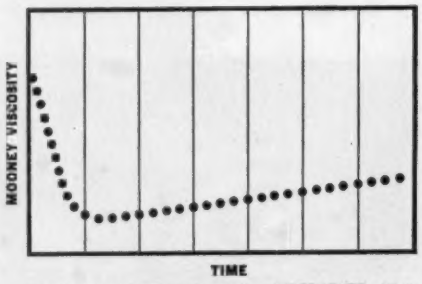
NEW FLUOREL® 2141

BRAND ELASTOMER

Its Mooney Scorch Rating is ideal for the fluorinated rubber processor because it makes possible fast, more economical cures with fewer defects, less scrap, fewer rejected parts. Material can be reprocessed with greater safety.

A SIGNIFICANT BREAKTHROUGH in elastomer processing has been made possible by 3M research through development of its new FLUOREL 2141 Elastomer.

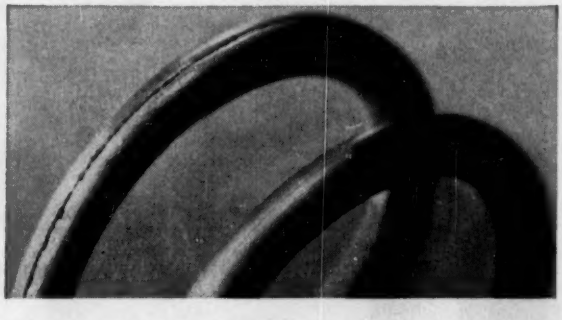
This remarkable new product has a Mooney Scorch Rating outstanding among fluorinated elastomers. The range permits the rubber processor to achieve fast, more economical cures with fewer defects, less scrap and fewer rejected parts. The inherent safety of FLUOREL Elastomer 2141 allows repeated reprocessing to produce high quality parts that meet military specifications or other critical end uses.



MOONEY SCORCH CURVE for FLUOREL 2141 Brand Elastomer.

At the same time, the outstanding physical qualities of the elastomer are retained. They include: non-combustibility, excellent resistance to corrosive chemicals, fuels, solvents and ozone, minimum compression set, rated for continuous service at 400° F., and the ability to tolerate 600° F. temperatures for reduced periods under certain service conditions.

If you use or work with elastomeric materials, it will pay you to examine the remarkable features of this new product. Examine, too, your present rubber products with an eye toward increasing their life and quality through use of FLUOREL 2141 Elastomer. For complete data, write today on your company letterhead to: 3M Chemical Division, Dept. KAL-30, St. Paul 6, Minnesota.



FLUOREL 2141 "O" ring, bottom. Note freedom from defects because of the improved scorch characteristics of FLUOREL Elastomer "O" ring as opposed to elastomer at top of photograph.

"FLUOREL" is a reg. T.M. of 3M Co.

CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

sharp

AMERICAN BI-METAL THERMOMETERS make accurate temperature readings sharp and sure at all check points

American Dial Thermometers are also available in mercury, vapor pressure, and gas actuation . . . on-the-spot and distant reading types . . . in sizes, ranges and stem lengths to meet your most exacting requirements.

sensitive

Any way you look at an American Bi-Metal Thermometer, you see exact working temperatures.

The two-level "Maxivision®" dial eliminates parallax effects. Numerals are on the lower level. Graduations are on the outer raised ring dial which presents a sheared edge to the tip of the pointer and in the same plane. To make readability even more accurate, the glass and graduated dial are closely spaced.

American Bi-Metal Thermometers are made of weather-proof stainless steel. All joints are welded to solid unity, then polished smooth so corrosion won't build up and destroy the thermometer's usefulness. And, you don't have to discard this thermometer even if the glass is ever broken. The bayonet lock bezel makes replacement easy.

Learn about the high sustained accuracy and long service life built into American Bi-Metal Thermometers. Phone your nearby industrial supply distributor for help in selecting the right type for each temperature check point in your plant. Or write for Catalog 100A.

MANNING MAXWELL & MOORE INC. MM&M TRADE MARK

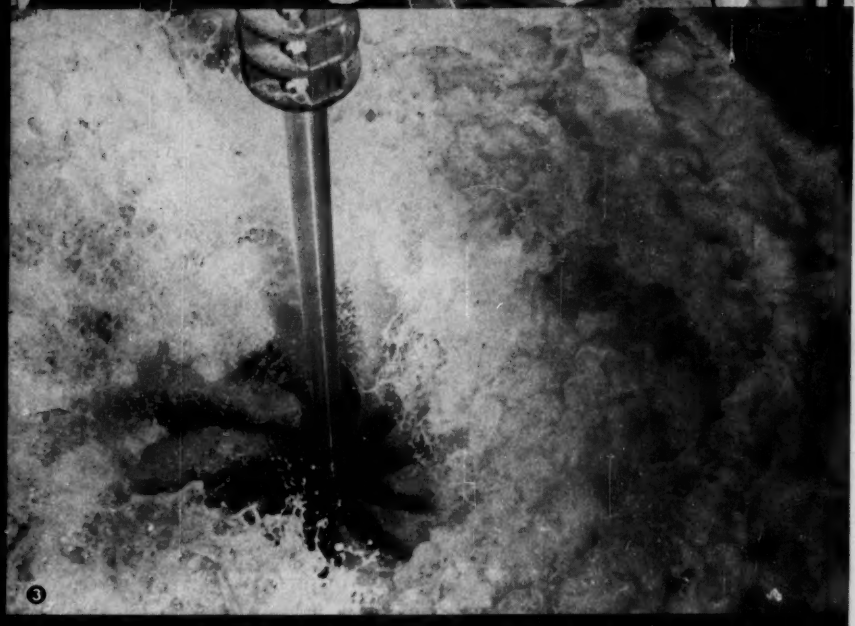
AMERICAN INDUSTRIAL THERMOMETERS

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

AT *fmc* . . . NINE YEARS OF COMPLETE MIXING WITH MINIMUM MAINTENANCE!



Improved Processing through Engineered Agitation

1 & 2. Drives of rugged Nettco mixers in Acid Mixing Room are periodically inspected—require minimum maintenance.

3. A complete mix is the result of Nettco Engineered Agitation in large tanks of hot phosphate solutions.

4. Soda ash dissolving in hot water . . . one of many Nettco mixing applications at FMC.

13 Nettco Mixers in Constant Service—and only two bearing replacements in *nine years*. This is NETTCO's performance record at the Newark, California plant of the Mineral Products Division of Food Machinery and Chemical Corporation.

Downtime Can Be Expensive—a breakdown can tie up an entire production line. In FMC production lines—atop large tanks of boiling liquids . . . subject to extremely heavy starting loads—operating in high humidity atmospheres—durable NETTCO mixers provide consistently balanced mixes with minimum maintenance.

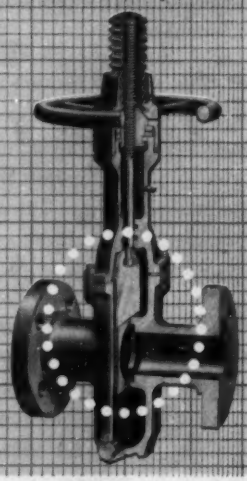
At FMC, Nettco Mixers are used for: agitating, mixing, reacting, suspending solids, blending miscible liquids, circulating, heat transfer and continuous treating. The results: Complete mixes, close product control and minimum downtime.

For Dependable Mixing—more profit in your process—contact your nearest Nettco representative. See Chemical Engineering Catalog or Refinery Catalog for address . . . or write for Bulletin 581.

NETTCO CORPORATION
87 Tileston Street
Everett 49, Massachusetts

NETTCO
ENGINEERED AGITATION SPECIALISTS
EVERETT 49, MASSACHUSETTS

PRODUCT OF W-K-M's *Creative Engineering*



FLOATING SEATS MAKE THE SEAL

Seats are specially formulated rubber molded to a hardened steel insert. They float against the gate. When the gate closes, line pressure forces the gate against the downstream seat making a tight seal. The upstream seat maintains its seal against the gate for an upstream seal. The valve provides a tight seal under little or even no line pressure or under vacuum conditions.

W-K-M's new Pressure Sealing Gate Valve

Almost without effort . . . you get a tight seal on *both* sides of the line. The secret? A unique seat design that puts line pressure to work *for* you. The greater the pressure, the tighter the seal!

Seats automatically adjust for wear . . . automatically relieve excessive body pressure. And on-the-line overhaul is easy.

Specify W-K-M's economical new Pressure Sealing Gate Valve for pressures to 720 psi (cwp) and temperatures to 250° F. Sizes 2″ through 30″. *At leading supply stores everywhere.*

WRITE FOR CATALOG 1200

W-K-M

DIVISION OF ACF INDUSTRIES INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

5925

CUT

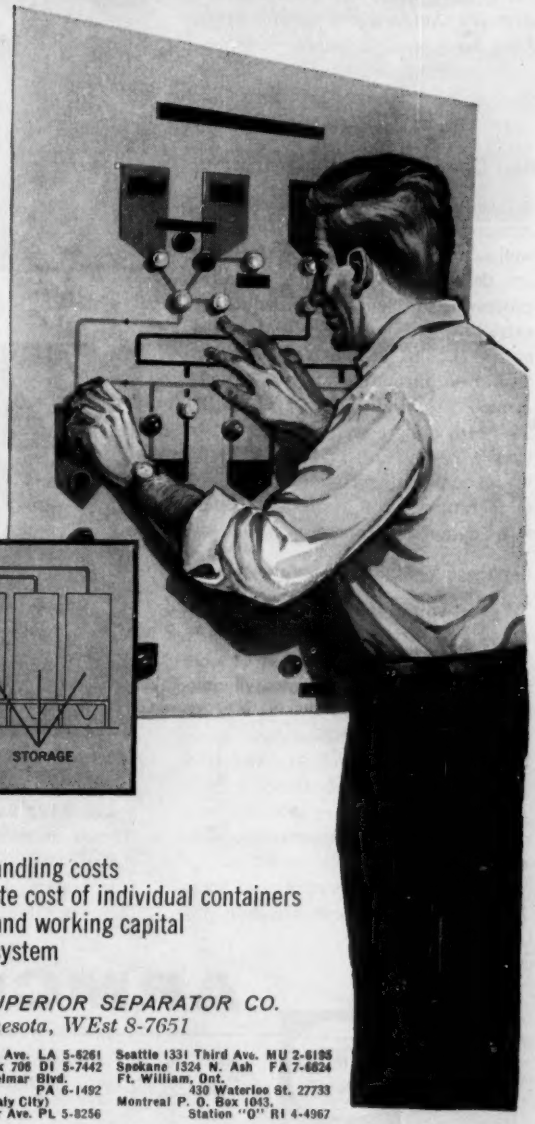
HIGH LABOR AND CONTAINER COSTS

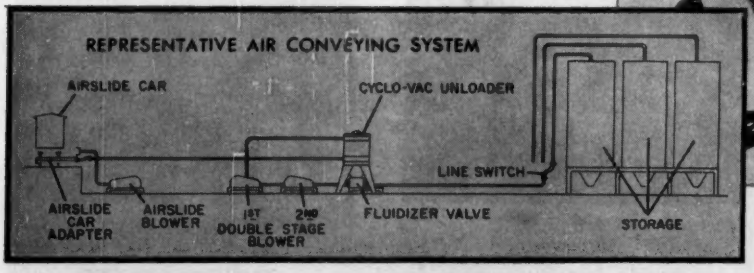
...with a

FLUIDIZER

Air Conveying System

AVERAGE SAVINGS RANGE
FROM $3.60 TO $6.10
PER TON OF MATERIAL





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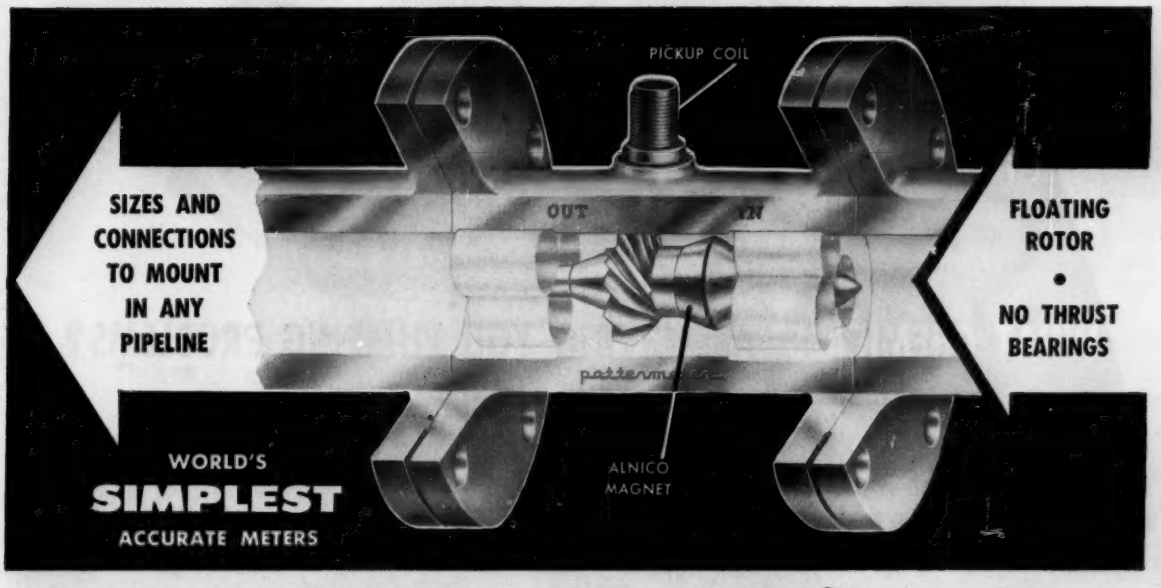

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A magnet built into the turbine driven rotor generates electric current directly proportional to the flow rate of liquid in the pipe. This impulse is used to activate electronic control and readout equipment near the meter or at remote locations. Accurate over wide range of flow rates and pressures. Handles liquids and gases.

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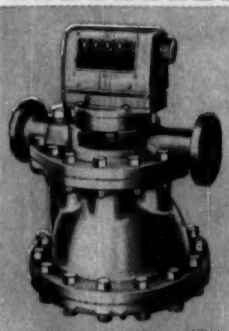
Operating Pressures	Unlimited
Temperature Ranges	−455° F. to +1500° F.
Pressure Drop	Virtually Nil
Connections	No limitation
Construction (standard)	Type 316 stainless steel with Carpenter #20 Rotor

READOUT and CONTROL equipment as needed

Potter-Bowser engineers gladly confer with systems engineers to provide data on any application requirements.



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BOWSER XACTO METERS AND PROPORTIONERS
positive-displacement piston type

Wherever mechanically driven readout and control equipment is indicated, and where positive-displacement metering is needed or costs less, Bowser Xacto Meters (leading all others in industry) are unexcelled for dependability and accuracy.
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Xacto Meter equipped proportioners are used to blend two or more liquids in continuous flow at accuracies to ¼ of 1 percent. First in lube oil blending, Bowser proportioners also handle most other liquids used by process industries.

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Anhydrous Ammonia
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Caustic, 50% Solution
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Where the pressures are high . . . or the liquids are tough to handle . . . that's for us!

The list above is typical of the special pumping problems we have solved for the process industries . . . problems that call for an intimate knowledge of what it takes to handle corrosive, viscous, abrasive or highly compressible fluids over a wide range of pressures and temperatures.

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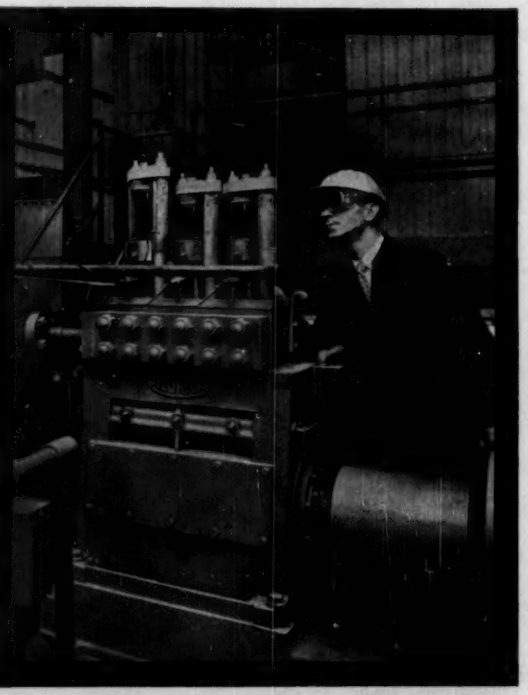

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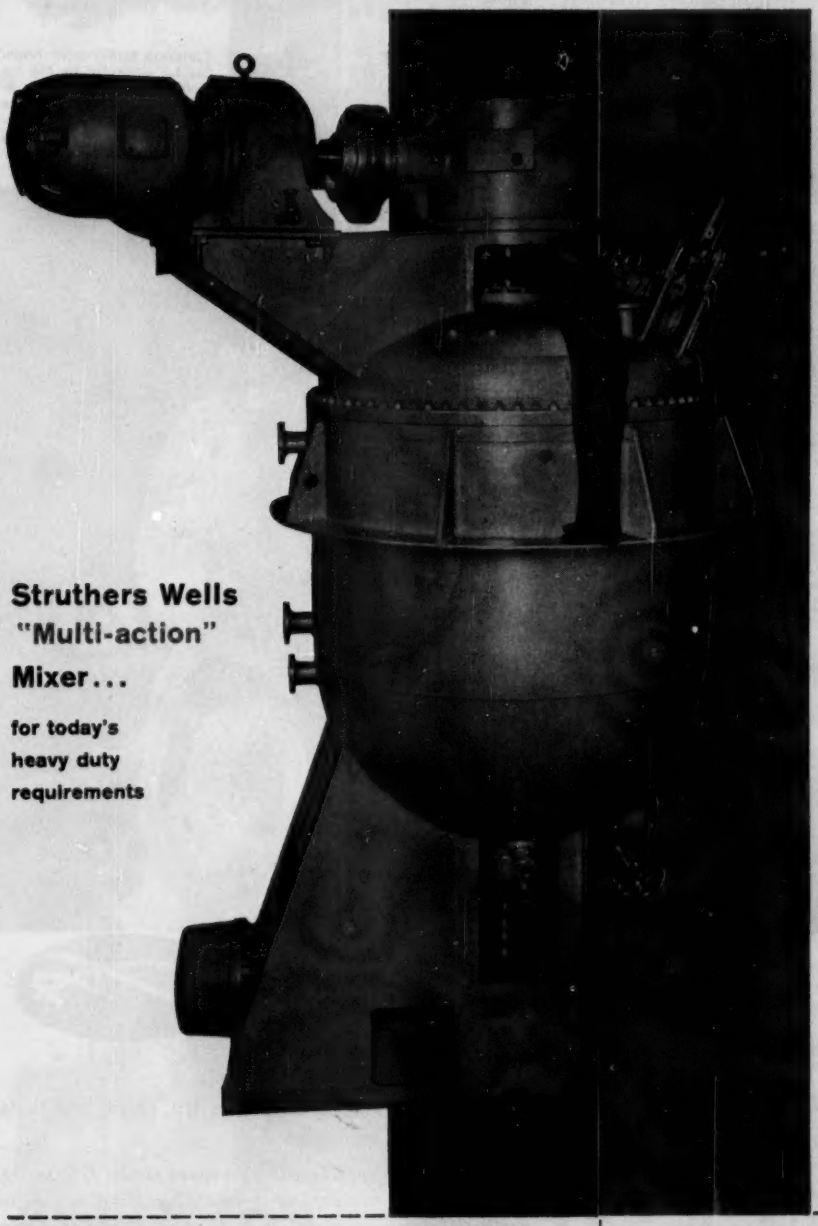

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7½ hp Ajusto-Spede Drive

Common motor-drive housing for units up to 7½ hp saves space — can be foot- or flange-mounted. Larger sizes up to 100 hp with individual motor and drive housings mounted integrally.

The Louis Allis AJUSTO-SPEDE® drive is more compact, precise, and trouble-free

Here's an adjustable speed drive that allows *truly precise* machine operation. Speed regulation is automatic and stepless — results in faster, more efficient production at lower cost, with less waste, and minimum wear on equipment.

These and other benefits are yours when you use the improved Louis Allis Ajusto-Spede drive. For example, it can be set before or during operation to deliver any desired speed within its range. Its *exclusive* tachometer feedback circuit monitors the output speed and *automatically corrects speed and holds it* regardless of load changes.

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®Ajusto-Spede is a registered trademark of the Eaton Mfg. Co.

The cast-iron housing keeps out dirt, chips, and moisture — resists corrosion.

The compact Ajusto-Spede also saves space. Integrally-mounted motor and drive simplify handling — can be easily adapted for installation on new or existing machines. Controls can be mounted at the machine or any other convenient position.

The Louis Allis Ajusto-Spede drive is the practical solution to almost every application that requires dependable, easily controlled adjustable speed. It is the answer to precise operating speeds for machine tools, process machinery, test equipment, windups, conveyors, printing presses, and other equipment. Contact your Louis Allis District Office for information and application help. Or write for bulletins 2750 and 2800 — The Louis Allis Co., 447 E. Stewart St. Milwaukee 1, Wis.

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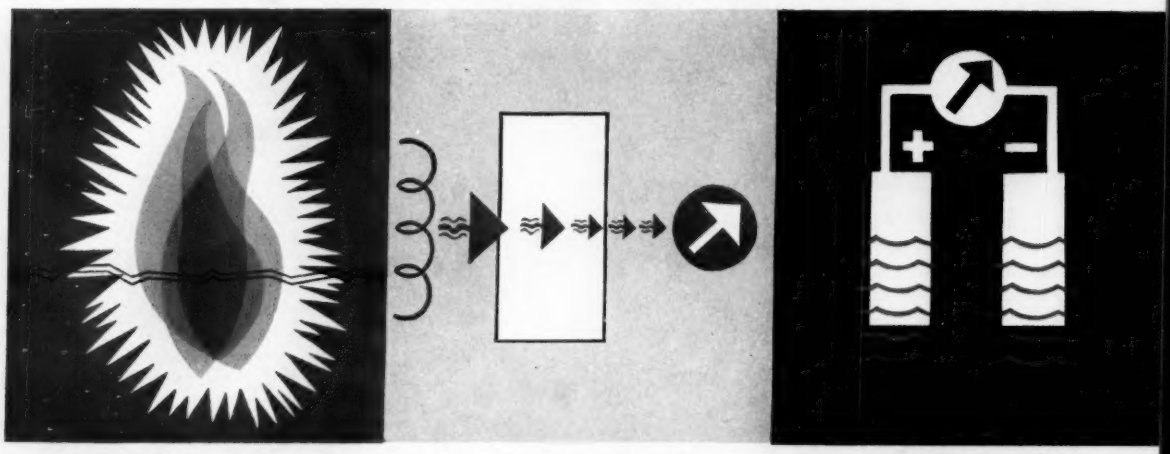

Catalytic Combustion **Infrared Analysis** **Depolarization**

MSA

INSTRUMENT DIVISION

Mine Safety Appliances Company

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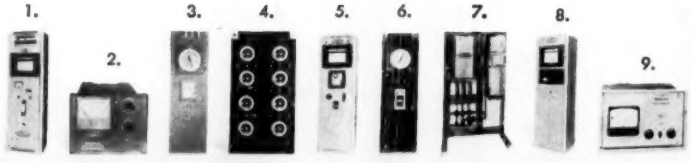

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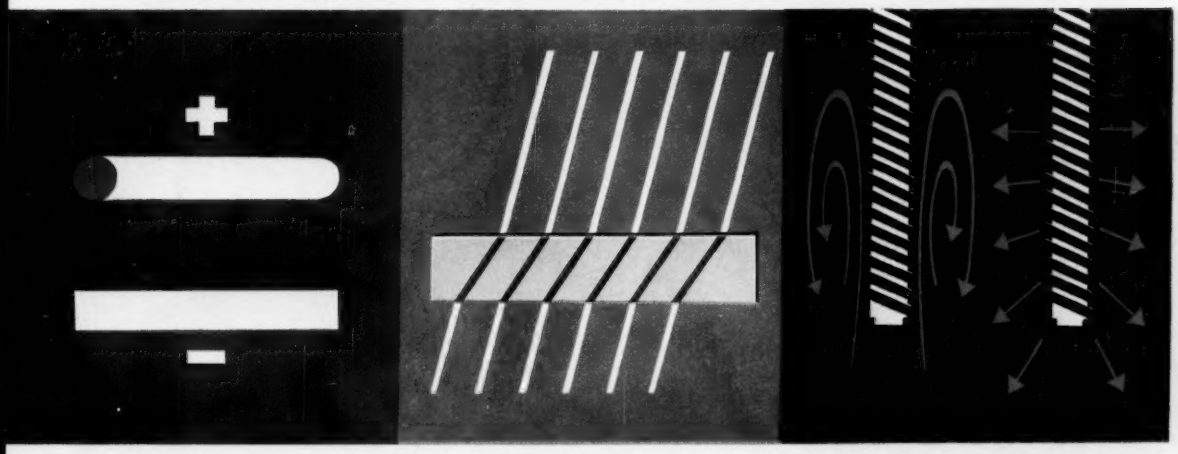
for dependable process stream analysis



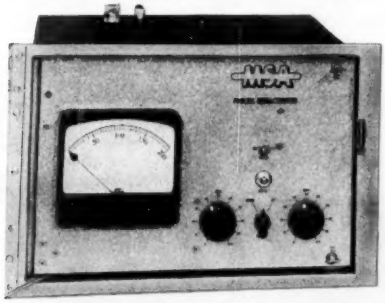
Ionization

Refraction: Now MSA packages the principle of light refraction for continuous measurement of organic and inorganic liquids.

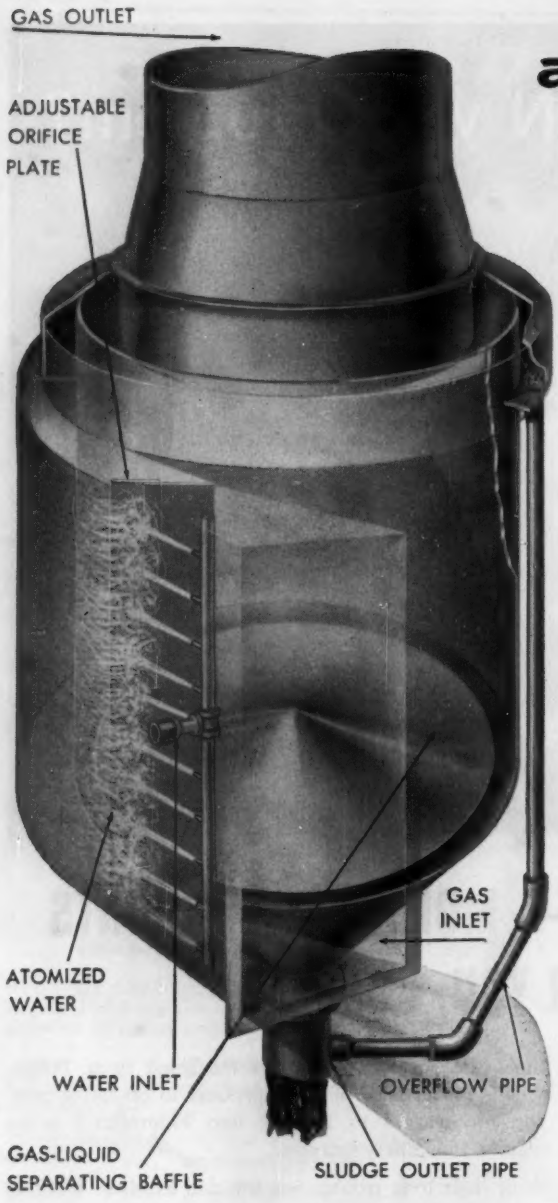
The new M-S-A® Process Refractometer shown below, compares the refractive index of a stream with a constant standard. Controls quality in either stream or batch processes. Converts to new problems quickly and easily.

MSA has been supplying industry with similar "brains" for gas analysis since 1922. So, we're not newcomers. Our people are competent professionals. And so are our instruments. Both are extremely articulate when it comes to process stream analysis.

There are many MSA approaches to measuring gas concentrations. From the simplest to the most sophisticated. Most of these approaches stem from the principles symbolized above. Write us for instrument literature on the new M-S-A Process Refractometer or any of our other process stream analyzers.



Thermal Properties



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THE DUCON TYPE VO Oriclone® SCRUBBER

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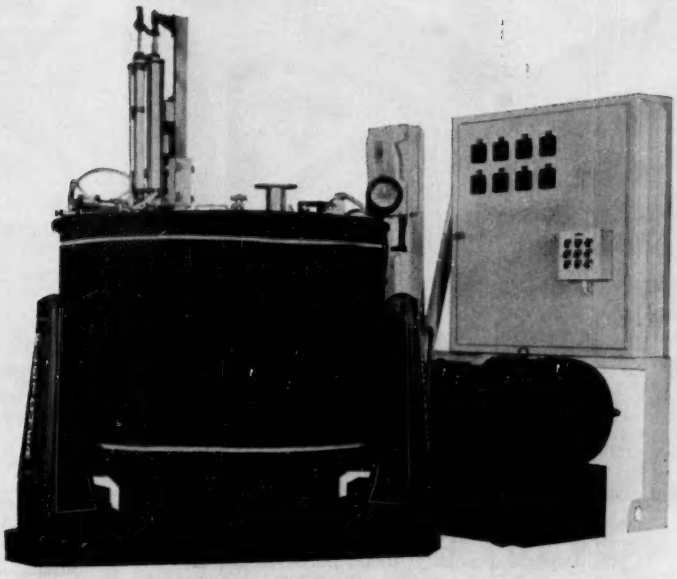
take another look at the FLETCHER TORNADO-MATIC



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- exclusive Fletcher control system automatically starts, feeds, spins, rinses, brakes, unloads, and then re-cycles around the clock.
- push button production cycles are set up, maintained, and can be changed at will — Tornado-matic centrifuges feature infinite variable speed drive.
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- Fletcher-Matic control engineered for each application — when your automatic Fletcher is installed it is ready-to-go on your product.

These Fletcher Tornado-matic "exclusives" can mean significant savings in your application. The day in, day out peak efficiency of dependable automatic production — with complete flexibility of control at your fingertips — is worth looking into. Get in touch with The Fletcher Division of The Sharples Corporation.

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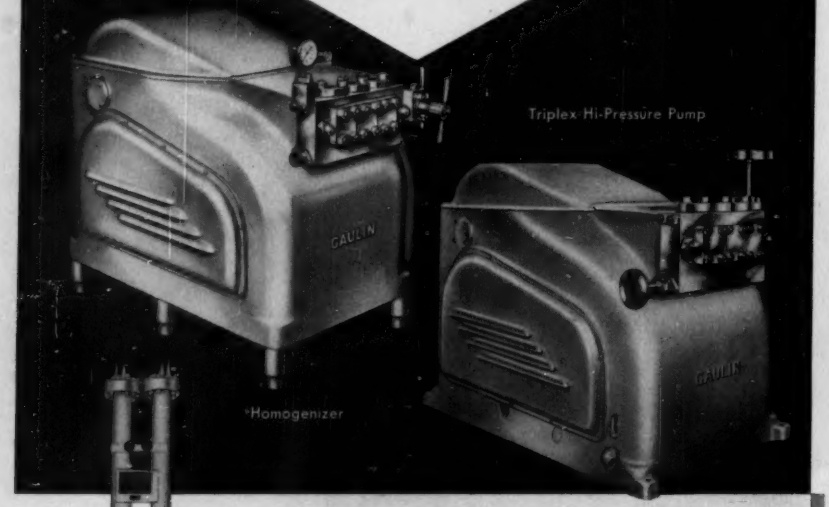

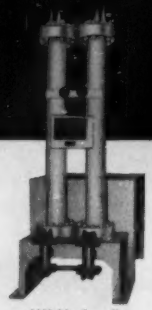

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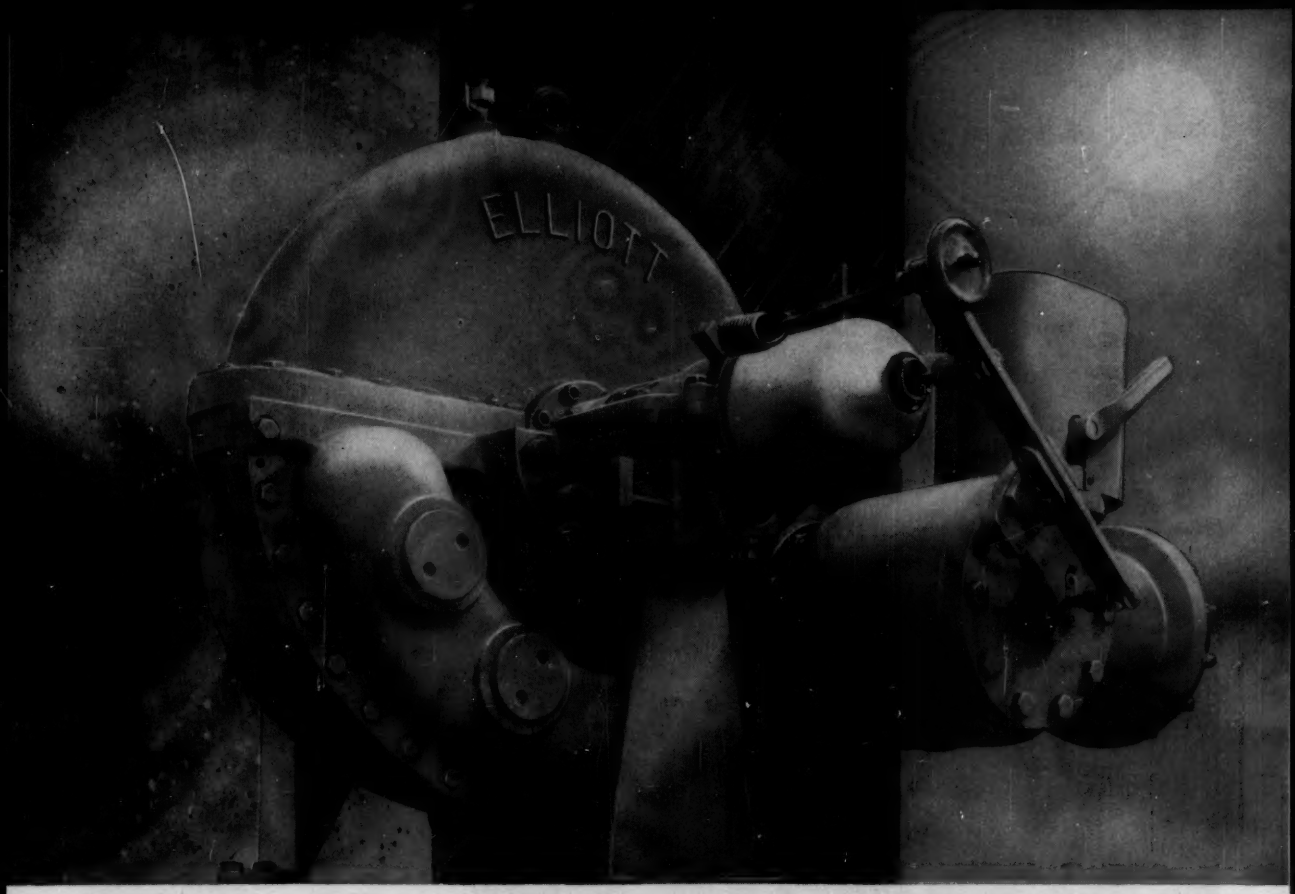

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day-in day-out

ELLIOTT Company

JEANNETTE, PENNSYLVANIA H9-2

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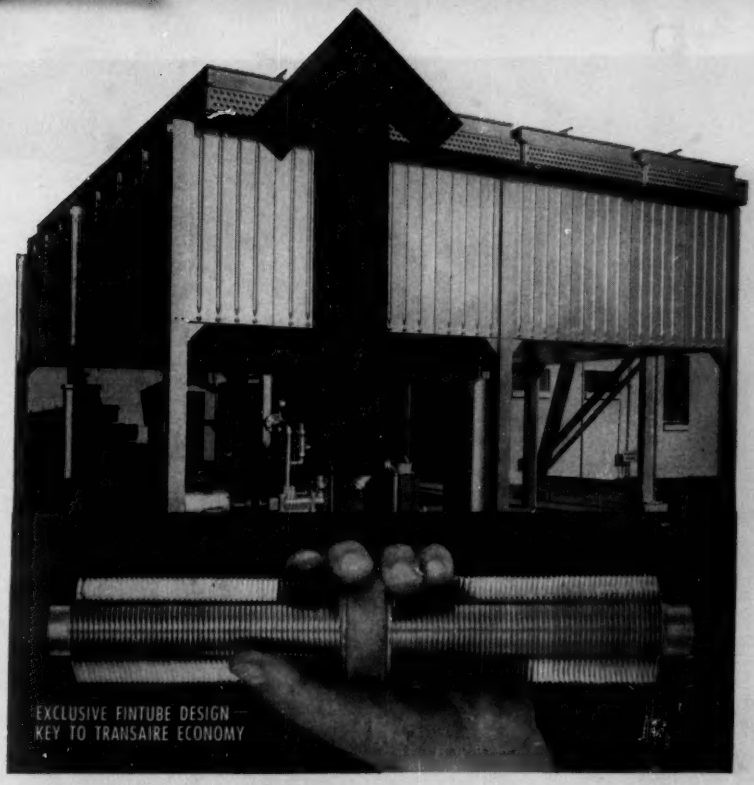
...AT LOW OPERATING COST



Transaire Air-Cooled Heat Exchangers use free air for most economical heat dissipation

When waste heat is to be dissipated, Transaire Air-Cooled Heat Exchangers do the job efficiently and economically. Simple in design, Transaire units are now being used in many varied processing operations. Even in areas where water is unlimited, the cost of providing cooling towers, pumps, water treating, etc., makes the use of Transaire exchangers attractive.

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specialists in heat transfer equipment

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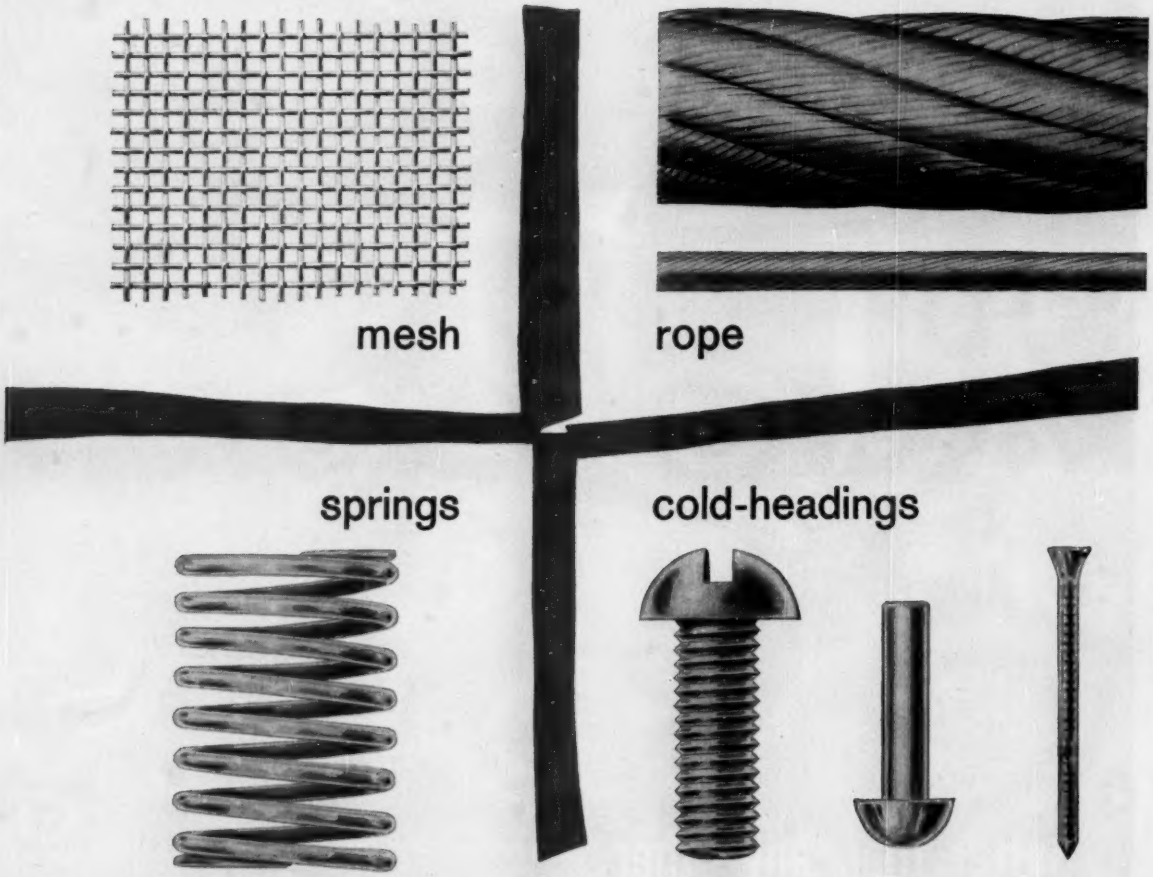
whatever you make in stainless steel wire



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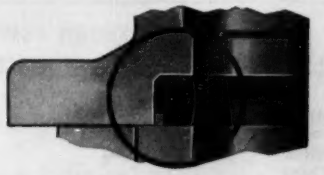
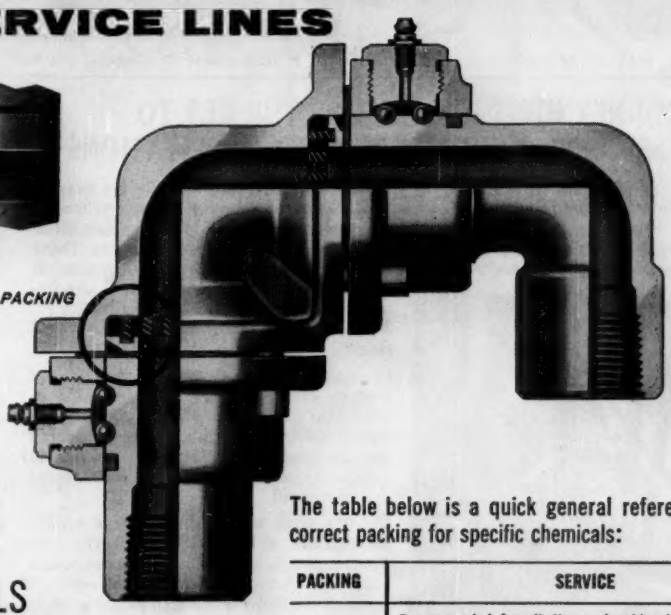


VIEW ABOVE SHOWS MOLDED PACKING

VIEW AT RIGHT SHOWS DISC PACKING



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The DS Series swivel joint with its broad service range can be a valuable new tool in your process system. Use it in chemical loading of tank car or tank truck, for stress relief in piping subjected to vibration, expansion or settling, or as a steam rotation connection between stationary and revolving equipment. Wherever you use it, you'll find it pays for itself in extended service life.

Using a disc or molded type packing, this swivel joint can be applied to handle steam and any of a wide variety of chemicals processed in your plant. And the split segment feature of the DS Swivel Joint allows replacement of packings without removing the joint from the line.

Buy and apply Chiksan DS Series Swivel Joints for chemical service lines in your plant now. You can select from eight basic styles for full rotation in one, two or three planes. For more information write to Chiksan or fill in the coupon below.

The table below is a quick general reference for the correct packing for specific chemicals:

PACKING	SERVICE
Neoprene	Recommended for alkaline and acid salt solutions and aldehydes such as formaldehyde.
Hycar	These should be used for petroleum derivatives, neutral or slightly acidic salt solutions, dilute acids (Sulfuric to 50%, Hydrochloric and Nitric to 20%), alcohols, glycols, ethers, gases (Oxygen not over 500 psi), and vegetable oils.
Butyl	Recommended for liquid or anhydrous ammonia, gases (except oxygen over 500 psi), ammonia derivatives such as hydrazine and for certain hydraulic fluids such as Pydraul, Skydrol, and Cellulube. It is recommended for acetone and methyl ethyl ketone.
Teflon*	Used for concentrated or fuming acids and other highly oxidizing fluids, esters, aromatics, liquid chlorine, bromine and fluorine if temperature is not excessive.
Asbestos	For use in saturated steam service.
Viton "A"*	Recommended for use with concentrated acids, aromatics, liquid chlorine, liquid bromine, chlorine or bromine derivatives, molten sulfur, and carbon disulfide.
Metallic	For extreme services such as hot gas at 600°F., a Stainless Steel metal disc, specially treated to prevent galling, is recommended.

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DEVELOPMENTS...

MARCH 21, 1960

Chementator

T. PETER FORBATH

American Viscose's new cellulosic fiber, called Fiber-40 while under test, has been named Avril and will go commercial at Nitro, W. Va., soon.

Aerojet-General has put on stream a 1-2-million-lb./mo. solid rocket propellant plant at Sacramento, Calif. Facility compounds ammonium perchlorate, polybutadiene, other ingredients under high-degree of automation.

Chemische Werke Huels has developed two new processes for making polybutadiene, will begin test marketing product this spring.

Latest to declare itself in the polypropylene sweepstakes: Japanese firm Ube Kosan. Montecatini most likely will supply flowsheet for 5,000-ton/yr. plant. Ube Kosan also expects to build 20,000-ton/yr. polyethylene facility.

New polyformaldehyde makers in wings

Du Pont's polyformaldehyde resin Delrin, which went commercial just last year at Parkersburg, W. Va., is already in for its first taste of direct competition. From opposite corners of the world this month comes word of advanced process work on similar, if not identical, thermoplastics:

• Kyoto University (Tokyo, Japan) professor, Seizo Okamura, has come up with a radiation route to polyformaldehyde resin which reportedly is now being readied for commercialization. In it, 40% aqueous formaldehyde solution (formalin) is dehydrated to less than 1% water content, then mixed with an unidentified solvent and cooled to —80 C. A "few seconds" of gamma irradiation in a cobalt-60 chamber produces the polymer. Material is said to have higher molecular weight, greater heat stability than Delrin.

• Badische Anilin- & Soda-Fabrik (Ludwigshafen, Germany) has taken a key step toward polyformaldehyde production with development of a process for making polymerization-grade formaldehyde. Company has applied for patents on a route to pure, stable formaldehyde gas based on decomposition of lower formaldehyde polymers such as paraformaldehyde with phosphorous pentoxide at low pressures (20 mm. Hg) and temperatures (60-80 C.). Reaction takes place in a ball mill. Resulting gas is stable up to 200 C., can be liquefied at —60 to —75 C. without forming lower polymers. Reports BASF, process will be basis for company's entry into polyformaldehyde resin manufacture.

Sludge acid: How dangerous?

Investigators of the explosion and fire, which killed one worker, at the new Dixon Chemical sulfuric acid sludge-recovery plant in Paulsboro, N. J., last January are still unsure of the cause of that disaster. But the question

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- **Eliminates normal "hot spot" below fixture**

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Now, at no extra cost to you, this new Crouse-Hinds Prismatic Globe reduces troublesome glare while increasing "seeing" brightness. Provides more efficient working light, by softening and distributing the light evenly – without reducing the amount of usable light.

By eliminating "hot spots", the Crouse-Hinds Prismatic Globe reduces eye-fatigue . . . especially important in areas where reduced worker efficiency is itself a potential hazard. Prisms are inside the globe to keep the exterior dust-free. Prismatic Globes are furnished with 100, 150, 200/300 and 300/500-watt sizes of Crouse-Hinds EV Series explosion-proof lighting fixtures.

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they're now asking is: Do the vapors given off by sludge acid represent an explosion hazard?

According to Dixon's plant manager, C. A. Barton, tests indicate that the answer could very well be yes. He believes Dixon's blast was set off by static electricity igniting sludge-acid vapors or by a flashback through the vent line (protected by a flame arrestor) connecting the sludge-acid-storage tank to the flue head of a waste heat boiler (*Chem. Eng.*, Jan. 11, p. 80).

Explosion occurred as tank was being filled with an acid sludge containing 6% total carbon. Sludge entered at top, fell through tank to bottom with ample opportunity for vapors to mix with any air in the empty vessel. To prevent any recurrence, Dixon now is blanketing its sludge tanks with CO_2 in much the same way that petroleum refiners store spent acid. Too, company is installing deep lines so that acid is pumped to the bottom of the tank without falling freely.

But not all sludge processors believe such measures are needed. Consolidated Chemical (Houston, Tex.) for one, points out that it has operated for many years without incident with vented tanks. It merely watches tank pressure closely and vents tanks to atmosphere when pressure gets too high.

And there's another possible cause for Dixon's explosion, Consolidated notes. It may have been caused by reaction between entering sludge and a different sludge already in bottom of tank. A plant overseas had an explosion in a sludge tank which careful investigation finally attributed to pressure buildup caused by violent foaming when different sludges mixed. Open-type tanks with shed roofs and careful testing of sludges before mixing them sidestepped this problem.

Liquid rockets still make big news

Despite impressive technical advances by solid-propelled rockets (*Chementator*, Mar. 7, p. 56) and the recent forecast by Air Research and Development commander Lt. Gen. Bernard Schriever that liquid-fueled missiles will not be produced after 1963, some of the biggest rocket news these days continues to be made by liquid propellants.

At a Congressional hearing last month it was revealed that the U. S.'s top thrust rocket now under development—the 9-million-lb. Nova—will be powered by a cluster of six 1.5-million-lb.-thrust liquid engines developed by North American Aviation's Rocketdyne Div. Vehicle, which has already been put through some preliminary tests, will measure 220 ft. tall by 44 ft. dia., burn a notably conventional propellant system of kerosene-type fuel and liquid oxygen oxidizer.

And it's learned that what presently is the U. S.'s highest thrust rocket (along with the Atlas), the 380,000-lb. Titan, is getting set to make a propellant-system change. But it's changing from one liquid system to another. Reliable reports have it that the Titan will switch from kerosene and liquid oxygen to hydrazine and unsymmetrical dimethyl hydrazine for fuel and nitrogen tetroxide for oxidizer.

Coal-chemicals venture presses ahead

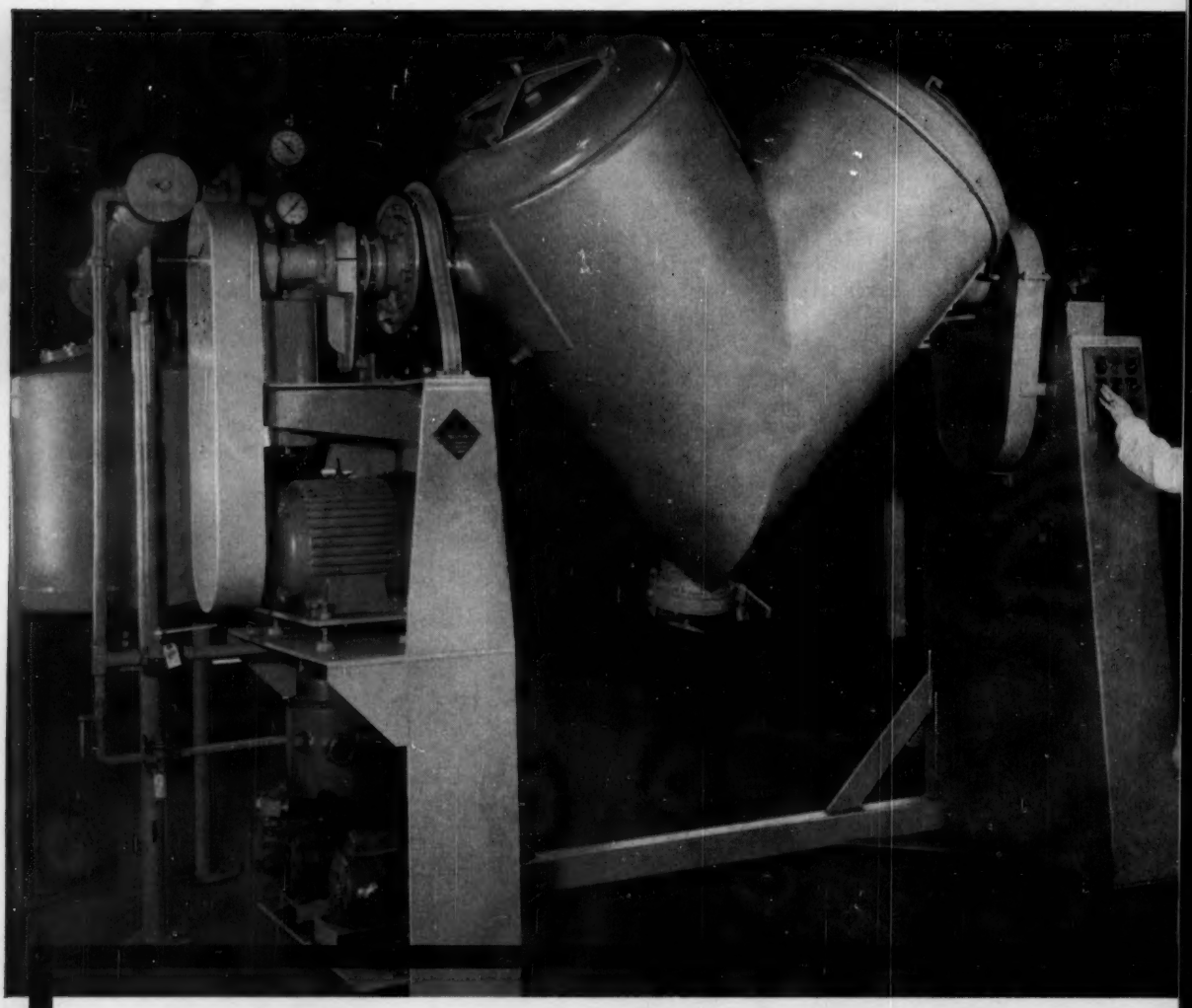
Despite General Dynamic's abrupt withdrawal from the joint coal-chemicals venture with Philadelphia & Reading, P&R declares it still intends to go ahead with the project—and make a handsome profit out of it. First contracts will be awarded in about a month; total cost will run to about $130 million when all phases are complete (*Chem. Eng.*, June 15, 1959, p. 82).

While some observers believe that GD became disenchanted with the economics of coal chemistry, P&R maintains that it has a unique opportunity to profitably upgrade 50 million tons of coal silt and 350 million tons of anthracite refuse using commercially proved processes. First item of business will be construction of a $50-$60-million, 300,000-kw. electric generating station to burn coal silt. Pennsylvania Power & Light is already burning a similar silt in a 105,000-kw. station for under 3 mills/kwh.

With its cheap power, P&R plans to make calcium carbide from anthracite, convert it to acetylene and vinyl chloride. Original plan with GD called for annual sale of 87,000 tons carbide, 50 million lb. acetylene and 150 million lb. vinyl chloride. P&R claims that the use of anthracite instead of coke to make carbide has already proved feasible in commercial-scale tests in Germany.

Second phase of project calls for a Lurgi gasification plant to turn out 50 million cu. ft./day CO_2-H_2 synthesis gas from a 25%- coal, 75%-rock anthracite waste. Flotation upgrading would furnish a sized feed for gasifiers, and coal fines that can be burned for power

(Continued on page 78)



Now for the first time you can combine vacuum-drying and liquid-solids blending in a single packaged unit — the new P-K Solids-Processor. This latest P-K "Twin-Shell" development dry blends solids, disperses liquids, granulates and dries in simple sequence.

DRY BLENDING — Solids are tumbled to give gentle precision blending. This may be done under vacuum or atmospheric conditions, in inert or sterilizing gas, with heat in jacket up to 200° F., or with cooling water circulated through jacket. When needed, intensive blending breaks up agglomerates or gives uniform dispersion of pigments.

LIQUID DISPERSION, GRANULATING — Minute or large percentages of liquid are uniformly dispersed into solids. Dispersion can be sufficiently intimate to provide lump-free production. Or it can be regulated to produce granulations of controlled size. As in dry blending, these steps can be conducted under vacuum or atmospheric conditions, in inert or sterilizing gas, with heat in jacket up to 200° F., or with cooling water circulated through jacket.

DRYING — The new packaged system allows vacuum drying of heat sensitive materials with continuous turn-over and re-blending of solids. During drying, small balls with an insulating crust that inhibits complete drying tend to form. A separately actuated agitator breaks these up, permitting drying to a finished fine powder. In final stages of drying, direct hot air or gas can be introduced to reduce liquid content quickly to a fraction of a percent.

All P-K Solids-Processor systems are completely packaged. Available in standardized models with charge capacities from one to fifty cu. ft.

which would pay for the cost of beneficiation. Including depreciation cost of the expensive Lurgi plant, P&R says commercial tests show it can turn out synthesis gas for about 20¢/1,000 cu. ft.

Synthesis gas can be converted to hydrogen through a water-gas shift, then used to made 700 tons/day ammonia. NH_3 could go into urea, ammonium nitrate and nitrogen solutions. Other possibilities: Use cheap H_2 for direct reduction of iron ore, or use methanation to make gas for peak-load utility purposes which could be sold for as high as $1.50/1,000 cu. ft.

Oil lubes for extreme-temperatures

Mineral-oil-based lubes *can* handle the extreme temperature jobs that they've been steadily losing during the last few years to synthetic materials such as dibasic esters (*Chem. Eng.*, Jan. 25, p. 62). And, on pactically all counts, they can handle them better.

This trend-bucking view, once little more than hopeful whistling-in-the-dark by petroleum companies faced with growing competition of synthetics from chemical firms, now is being voiced with increasing validity. Reason: Development of new and improved processes for deep dewaxing hydrocarbons that yield products of extremely low-temperature pour points, good thermal and oxidation stability at high temperatures, minimum corrosiveness and low cost.

Case in point: M. R. Fenske of Pennsylvania State University, working under Air Force sponsorship, reports that a mineral-oil lube with a —75 F. pour point and thermal and oxidation stability up to 700 F. can be produced by using a combination of low-temperature and solvent dewaxing. Procedure: Severe hydrogenation of petroleum fraction to produce a white oil, distillation of a narrow (25 F.) boiling range hydrocarbon, extraction of paraffins at around —80 F. with high-molecular weight ketone solvent. Lubes so made are now under evaluation by Air Force, can be produced at costs "attractively lower" than the $3-$5 price of synthetics.

Indiana Standard is currently eyeing extractive crystallization of paraffins from hydrocarbons with urea as another process by which mineral oils can be put in competition with synthetics. Company has been intermittently operating a urea-dewaxing plant since 1958 at Whiting, Ind., capable of producing 10 million gal./yr. of special low-pour-point auto transmission oil (*Chem. Eng.*, Nov. 1956, p. 114). Now that plant is shutdown while studies are under way to determine how best to turn it to job of making extreme-temperature lubes and hydraulic fluids. Sonneborn (Petrolia, Pa.), reports that its work with urea dewaxing, until now focused on producing white oils for medicinal and cosmetic applications, will also be turned to making extreme-temperature lubes (*Chem. Eng.*, May 18, 1959, p. 142). And word comes that the Russians have developed a urea-dewaxing process for manufacturing low-pour-point lubes, are currently operating a 1,500-ton/day plant at Moscow Oil Refinery. Process also dewaxes jet fuels for low-temperature service.

Computer-run plant: Approach outlined

Of the two chemical firms that just announced "first" computer-controlled plants—Monsanto and B. F. Goodrich (*Chementator*, Feb. 8, p. 55)—Goodrich is beginning to outline what's involved at its new vinyl chloride addition at Calvert City, Ky. James Madigan, company's development scientist in charge of project, revealed these points about the $225,000 computer installation in talks before groups in Chicago and New York last month:

- Besides control of the vinyl chloride plant, computer (a Thompson-Ramo-Wooldridge RW-300) will eventually control simultaneously an entirely separate acrylonitrile plant. Presently, unit is scanning and logging variables in that facility.
- Computer is expected to reduce operating costs and improve product-quality control of vinyl chloride plant. In acrylo facility, it also is expected to increase production.
- About 128 variables from the two plants will feed computer; nearly half will be thermocouple signals, the rest, 0-10-v. transduced signals from plant pneumatic controllers. Outputs from computer—8 for vinyl chloride, 16 for acrylonitrile—will reset controllers in cascade fashion. Five computer output setpoints are now on the vinyl chloride plant, the other three are to be added later as will all 16 setpoints for the acrylo plant.
- Until acrylo plant loop is completed, empty computer capacity will be used to calculate mass spectrometer analyses in off-line duty.

Under computer control, vinyl chloride process (thermal cracking of ethylene di-

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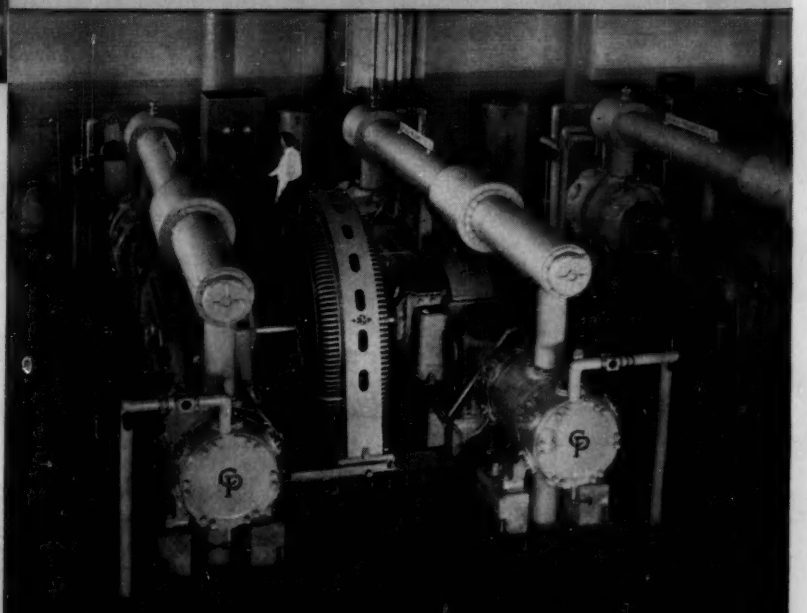
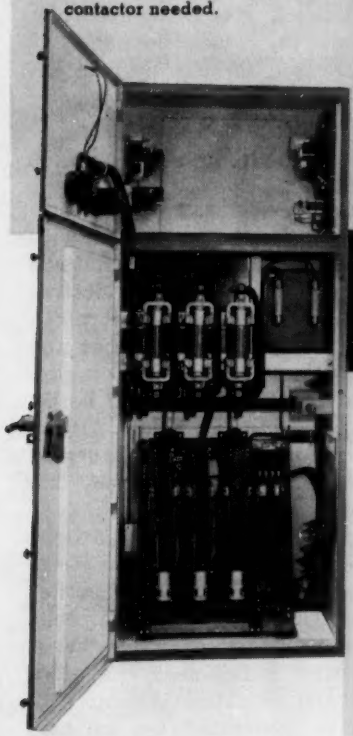


Above and at right • Four EC&M 1000 HP, 2300 Volt Synchronous Starters on air-compressor drives in Chrysler Corporation's new Ohio Stamping Plant at Twinsburg. Purchased and installed by Hatfield Electric Co., Cleveland, Ohio.

Below • Inside view of starter showing compact arrangement of fuses and contactor. The three arc shields slide out for quick access to both front and rear contacts—no draw-out of contactor needed.



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chloride, possibly at 50 psig., 900-950 F.) is scanned every 5 min. Control program runs every 20 min.; logging runs every hour and day; control-program optimization, every 8 hr. (Acrylo plant will be similarly handled.) Object of vinyl chloride optimization: To calculate best reactor conditions, including feed rate and conversion, while meeting but not exceeding a given monthly production goal.

Tomorrow's Technology

Today's embryonic developments which have special significance for chemical engineers

Nitric pulping may get another try

Researchers at the University of California are dusting off the nitric acid pulping process in the belief that it may be well suited to special conditions existing in the Golden State. Though many claims have been made for this route (*Chementator*, Jan. 1955, p. 104), its virtues have not yet earned it a commercial try in the U. S. And the one company that tried it in France reportedly has been less than satisfied with the results.

Nevertheless, U of C's D. L. Brink notes that the large quantities of logging residue in California would make an ideal base for nitric pulping operations. State's strict water regulations, severely limiting amounts of industrial waste that can be dumped into rivers, have so far discouraged pulpers' thinking in terms of usual pulping flowsheets. But, claims Brink, nitric pulping is another story because effluent from a nitric pulp mill could be used as nitrogen fertilizers for California's booming farms, thus eliminate the stream-pollution problem.

A nitric-based mill would pulp chips with HNO_3 at atmospheric pressure for about 3-4 hr. and at 50-100 F. After digestion, cook would be extracted and washed with NH_4OH. Products, besides slush pulp, would be concentrated to a nitrogen-containing solid pulp and a dilute nitrogen solution. Latter could be added to irrigation water or applied directly to crops.

Fluid bed for another U-fuel job

Uranium-fuel makers continue to find in fluid-bed technology a highly versatile and economic processing technique. In past years they've named it to an impressive array of key jobs including reduction of U_3O_8 to UO_2, reduction of UO_3 to UO_2, hydrofluorination of UO_2 to UF_4 and fluorination of UF_4 to UF_6. Now Mallinckrodt Chemical reports that fluid-bed reactors can also be turned to the task of denitrating uranyl nitrate to uranium trioxide —a vital reaction stage in the uranium-fuel plant that the company runs for the Atomic Energy Commission at Weldon Spring, Mo.

Mallinckrodt, working under AEC contract, bases this view on data gained from a 10-in.-dia. by 6-ft.-tall stainless steel pilot reactor with a production rate of 150 lb./hr. operating at 600-800 F. Reporting to last month's American Institute of Chemical Engineers meeting in Atlanta, Ga., company declared that fluid-bed denitration offers (1) ability to put an otherwise batch operation on a continuous basis, (2) excellent control over operating conditions, notably temperature, (3) high-purity (99%) free-flowing granular product ideal for subsequent processing stages, (4) high-production capacity in economically sized equipment and (5) reduced possibility of personnel exposure to hazardous uranium trioxide dust.

Research and development briefs

Oxygen for spacemen may best be provided by purely chemical processes. One with standout possibilities, under study at Battelle Memorial Institute (Columbus, Ohio), involves reduction of CO_2 with hydrogen over alkali metal or hydride catalyst to give carbon and water, followed by electrolysis of water to produce oxygen and hydrogen. H_2 would be recycled for initial reduction reaction. Attractions of this scheme are that apparatus needed would be lightweight, reliable, efficient and consume minimum energy.

Ceramics to resist over 4,000 F. have been developed by Boeing Aero-Space Div. (Seattle) researchers under Air Force contract. Zirconia, hafnia, thoria and compounds of hafnia-thoria, hafnia-lanthana and hafnia-neodymia show striking erosion and oxidation resistance to such temperatures generated by an oxy-acetylene flame. Too, Boeing has come up with a zirconia binder that can be molded at room temperature, cured at 800 F. and used at over 4,000 F.

For more on DEVELOPMENTS.....82

PROBLEM: An effective solid catalyst was sought for the alkylation of isobutane with ethylene to produce diisopropyl, a high octane gasoline component valuable for its high lead susceptibility and excellent volatility.

SOLUTION: Use of BF_3 with certain hydrated salts produces active alkylation catalysts which bypass many problems encountered with known catalysts. These new catalysts can be used at low temperatures—thus avoiding undesirable side reactions and mixing problems due to changes in viscosity.

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INVESTIGATE B&A® *BORON TRIFLUORIDE*

The versatility of boron trifluoride and its cost-cutting advantages make it a catalyst to be considered in almost any organic synthesis problem. The use of BF_3 as an alkylation catalyst in the preparation of diisopropyl (described above) is an excellent recent example. The next synthesis problem BF_3 will help solve may well be *yours!*

Here are some of the reactions catalyzed by BF_3: polymerization, alkylation, esterification, nitration, sulfonation, halogenation, isomerization, arylation, cyclization, hydration, acylation, and there are more!

Baker & Adamson has long been the leader in BF_3 research and production. We were the first to introduce boron fluoride etherate to industry. We pioneered in shipping the compressed gas by tube trailer transport—making it readily available in large commercial quantities. Steady, dependable supply is assured when you call on B&A for boron trifluoride.

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- Boron Trifluoride, Ether Complex, Tech.
- Boron Trifluoride, Ethyl "Cellosolve" Complex
- Boron Trifluoride, Hexamethylene-tetramine Complex
- Boron Trifluoride, Monoethylamine Complex
- Boron Trifluoride, Monohydrate
- Boron Trifluoride, Para-cresol Complex
- Boron Trifluoride, Phenol Complex, Tech.
- Boron Trifluoride, Piperidine Complex
- Boron Trifluoride, Triethanolamine Complex
- Boron Trifluoride, Urea Complex

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Steel Process Switch: Steam Instead of Oxygen

According to a brief report in Tass, the Soviet news agency, Russian metallurgists are enjoying good results with a variation on the oxygen-blowing technique used in many open-hearth furnaces throughout the world. By simply injecting superheated steam at 185 psig. into the furnace, steel output can be upped by as much as 10%.

This new technique has reportedly been used in open hearth furnaces in the Ukraine for over a year. Use of steam instead of oxygen eliminates capital investment required for an oxygen plant (since steam facilities are already available) with corresponding reductions in operating costs.

Plastic Pipe Holds Up Under Fire

Developed for oil field use, unusual properties of new plastic pipe may lead to process plant applications.

Esso Research & Engineering's new glass-reinforced Buton plastic pipe has literally come through a baptism of fire: To prove the pipe's ruggedness, Esso immersed it in the flames of a gasoline fire for 15 min. The pipe survived this torture test, both when empty and when filled with water at 30 psig.

According to Esso, the improved plastic pipe is expected to find extensive use in oil producing fields where its high corrosion resistance, light weight and good temperature properties will outperform steel in corrosive environments. Esso won't say much about cost, only that "total cost, including installation and long-term maintenance is expected to make the pipe competitive with steel."

Field studies show that pipe can be installed on flat terrain faster by two men than ordinary pipe can by a five-man crew. Pipe withstands temperatures from −40 F. to 300 F. and its resistance to water makes it ideal for underground installation.

Pipe lining, made by compounding synthetic rubber and a new resin (butadiene-acrylonitrile rubber and PVC), prevents internal abrasion and erosion of the glass reinforcing material. Resistant to oil and chemicals, the lining is vulcanized at the same temperature at which the pipe is cured, giving a strong bond between resin and lining.

To cure similar oil field corrosion problems on the opposite side of the globe, engineers are looking at an entirely new kind of pipe. According to Soviet press reports, Russian engineers have employed plywood pipelines with "excellent" results in oil fields where high-sulfur crudes have destroyed conventional pipe in three months.

So impressed are the Russians by the results, in fact, that a plant in Leningrad is now reportedly shipping plywood pipe to more than 100 use points. However, U. S. observers believe that the switch to plywood was dictated more by a lack of adequate plastic pipe technology rather than by any outstanding advantages of the plywood.

Two New Processes Are Behind Plastic Powder

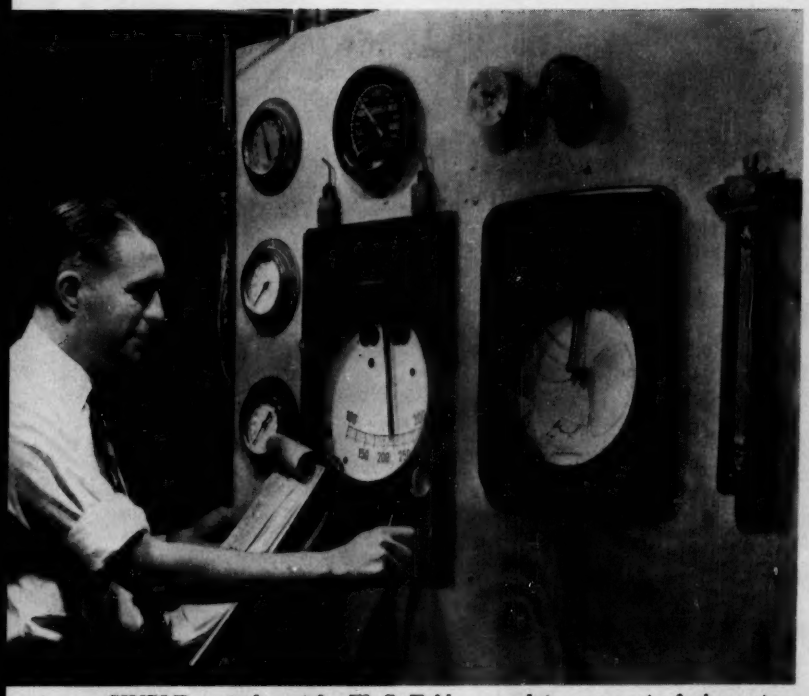
Capitalizing on a couple of processes originally pioneered in Europe, U. S. Industrial Chemicals will soon be marketing commercial quantities of finely divided (powdered) polyethylene. Trademarked Microthene, the powder will be produced in a new 2-million-lb./yr. facility at Tuscola, Ill.

With the introduction of a steady supply of this new material, U. S. I. sees polyethylene finding new applications in such things as textile coatings, drum linings and specialty paper coatings. Extremely large moldings can also be made from the powder through new molding techniques (see *Chem. Eng.*, Mar. 7, 1960, p. 68). Introductory prices for the material will be 65¢/lb. for fine grade (under 200 mesh) and 40¢/lb. for coarser grade (50 to 200 mesh).

Previous attempts to make powdered polyethylene by conventional grinding techniques have been thwarted by heat generated in the machinery which melts the plastic. However, U. S. I.'s new grinding process for making 50-200 mesh material avoids these pitfalls by using a German-made combination squirrel-mill and hammer-mill grinder.

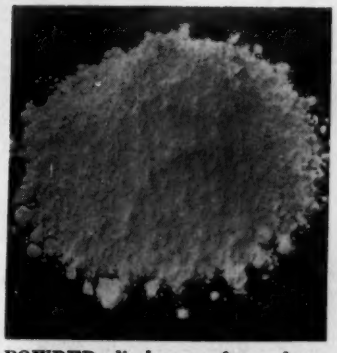
Polyethlene pellets feed to the mill via an air conveyor; large volume of air flowing through the mill also acts as a coolant. Ground particles are then pneumatically conveyed from the mill, sized on a vibrating screen and finally separate out in a cyclone separator.

Grinding is too inefficient to make minus 200 mesh powder, however, so U. S. I. turns to a Swiss-developed solution process. Polyethylene pellets dissolve in an unidentified hot hydrocarbon solvent, then precipitate out as fine particles when large volumes of cold water are injected into the solution.



SIMPLE controls, set by W. S. Eakins, regulate new paste drying setup.

PASTE as heavy as 100,000 cps. feeds satisfactorily through new dryer nozzle.



POWDER discharges from dryer unagglomerated and ready for use without grinding.

With automatic, low-cost setup, new process dewaters fine-particle slurries to heavy pastes and dries pastes directly to unagglomerated fine powder.

New Easy Way Changes Paste to Powder

A new way to atomize heavy pastes promises lower cost and improved product quality in converting slurried fine solids to powders.

Successful use of this technique, developed jointly by J. S. & W. R. Eakins, Inc.,[1] and Proctor & Schwartz, Inc.,[2] permits the spray drying of heavy pastes of fine solids without need to reduce viscosity through dilution or deflocculation.

Since cost of spray drying is an exponential function of the water content of the feed, this paste-handling feature permits reduction of cost by dewatering feed a maximum amount ahead of the dryer.

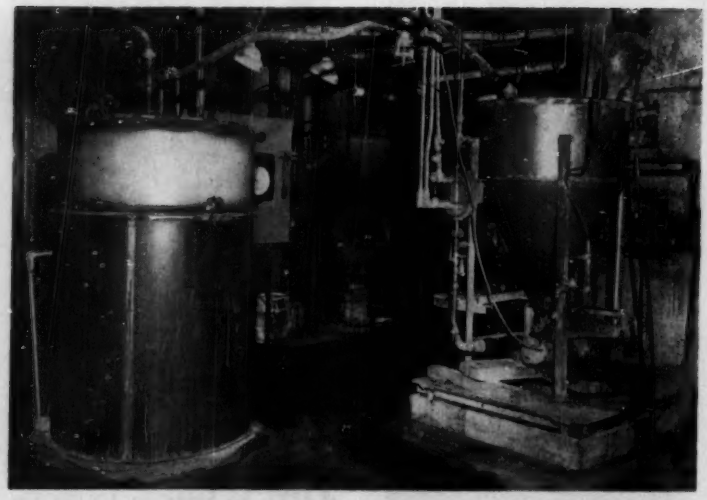
▶Handles Many Products—Eakins has proved how it can dewater fine solids a maximum amount and spray-dry the resultant heavy pastes on a wide range of materials, including titanium dioxide, iron oxide, calcium carbonate, clay, stearates, corn starch and color pigments.

First, a continuous horizontal solid-bowl centrifugal dewaters the fine solids to a heavy paste. Then, the new atomizer feeds the heavy paste into a spray dryer. Product discharging from the dryer is ready for use without any further size reduction.

Using this combination, the total cost of dewatering-drying-packaging sequence is a mere 0.7-1.5¢/lb., including labor and utilities but excluding capital and depreciation. With large installations, additional reductions up to 50% are possible.

▶Nozzle Holds Secret—To obtain atomization of heavy pastes, Eakins and P&S came up with

[1] 55 Berry St., Brooklyn 1, N. Y.
[2] 7th St. & Tabor Rd., Philadelphia 20, Pa.



PASTE from tank on right feeds into top of spray dryer on left at Eakins.

a two-fluid nozzle which is amazingly efficient, reports W. S. Eakins, vice president of the Brooklyn pigment-color company. Using only 0.17 lb. of steam/lb. of 100,000-cps. paste, this nozzle produces uniformly fine particles.

On pigments, final product is so fine that average particle size is 4 microns, based on tests at the Univ. of Wisconsin. Dried by other means, the same material needs pulverizing in a fluid-energy mill to reach approximately the same final particle size.

In order to assure uniform, uninterrupted performance of the nozzle, Eakins uses a special device which it developed to remove tramp particles from the feed solids. Thus, there is no danger of interrupting operation by plugging the nozzle.

▶ **Dryer Setup**—Initial setup of this dewatering-drying process at Eakins' plant centers around a gas-fired, semi-works spray dryer, 4½-ft. dia. by 16 ft. high. Designed to evaporate 300 lb./hr. of water with 500-F. temperature drop, the dryer is set up for 750 cfm. air flow.

Feed material, dewatered to a 55-65% solids paste by a continuous centrifugal, moves via piston-type mud pump to dryer feed tank. To exercise good control over particle size in the finished product, paste feeds to dryer through system which holds a constant ratio of steam flow to solids.

▶ **Vary Solids Rate**—Because steam pressure varies at Eakins plant, constant ratio can be attained only by measuring steam flow and adjusting solids feed rate accordingly.

An orifice meter measures steam flow while a magnetic flow meter keeps tabs on flow of feed. Ratio of steam to feed is held constant by a ratio controller acting through a variable-speed transmission which drives a positive-displacement pump.

Dryer discharges into a dust collector which delivers product to bagging equipment. Instrumentation on dryer includes safety purge and flame failure controls on gas burner, as well as temperature controls on dryer outlet.

Inlet temperature is allowed to rise and fall in response to load. Since exposure of product to heat lasts only 10 sec., inlet temperatures can range up to 1,000 F.

On pigments, this short, high-level temperature causes no harm, even though the same pigment may suffer under several minutes exposure at the 350-F. level.

▶ **Availability** — Patents have been applied for on the system and special devices. The nozzle, in particular, is considered to be especially interesting for application in other fields because of its high efficiency. Eakins and P&S expect to work out arrangements with interested parties for use of the drying system and/or the special devices.

Research Extends Limits Of the "Common" Metals

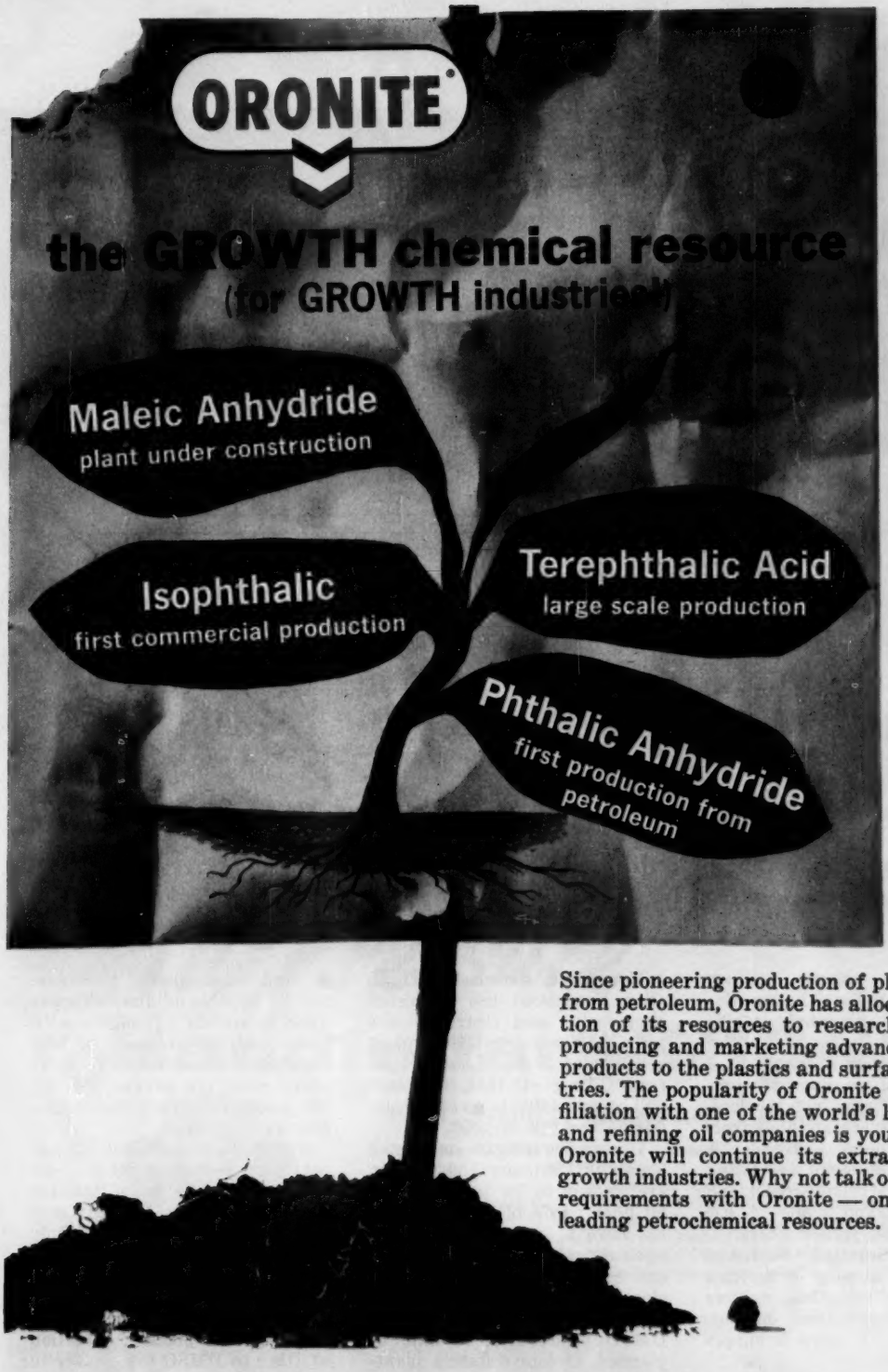
In the face of blazing headlines about "exotic" metals, producers of the less glamorous materials are extending the temperature and strength limits of steels and other alloys to points thought impossible a few years ago—making it more difficult for the higher-priced new metals to win acceptance on the basis of their superior performance.

Two new high-strength steel alloys have appeared lately. Universal Cyclops has introduced its Unimach UCX2 which boasts a yield strength of 225,000-235,000 psi. with proper heat treatment. Developed for casings of solid-fuel rocket motors, alloy is a modification of AISI 4100 series with addition of 1% Co. U. S. Steel also has a new high-strength steel (called USS Strux) which reportedly possesses a yield strength around 240,000 psi.

Too, advances in the "ordinary" high-temperature metals such as the high-nickel alloys are pushing the use limits of these metals up to the 2,000-F. mark, once considered the exclusive domain of more expensive metals such as columbium. Now available in commercial quantities is the well-known Rene 41, a high-nickel alloy that can be used up to 1,800 F. At 1,400 F. it has a yield strength of about 120,000 psi.

American-Marietta recently announced development of a non-exotic high-temperature alloy that will be used in turbines of new hot-running jet engines. Although details about this new alloy are under tight security restrictions, it is a good bet that it has a use temperature around 2,000 F.

Processes & Technology continues on page 86.



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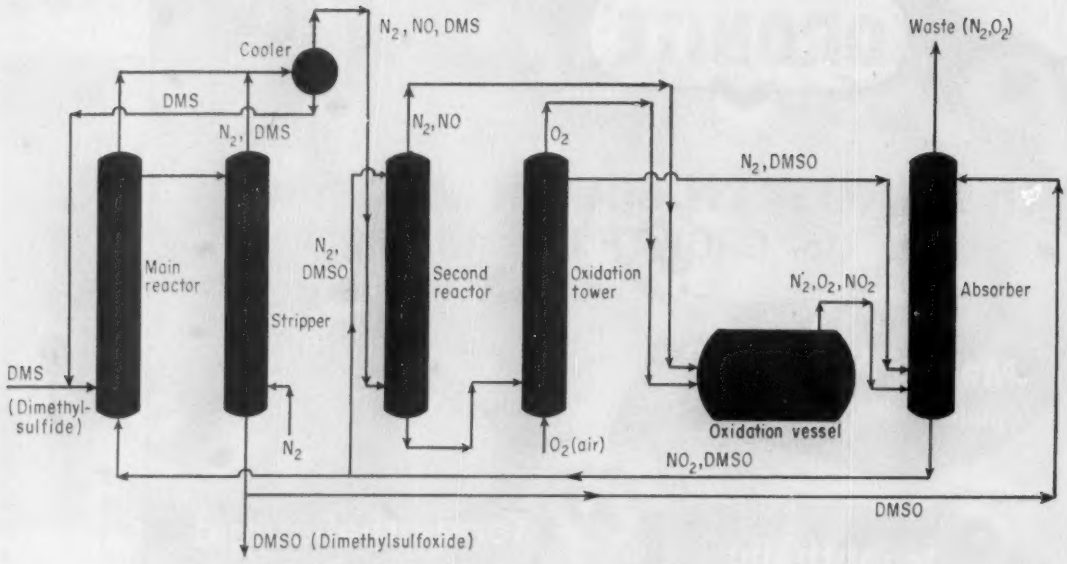


Dimethylsulfoxide Vies for Status

Used by one fiber maker, scheduled for work by another, under test by a third, DMSO may be on the verge of an upsurge. Here's how it's made and used.

From its present solitary major job at Toyo Rayon Co., Osaka, Japan, dimethylsulfoxide (DMSO) now seems poised for moves into other fiber plants.

At Osaka, Toyo reportedly precipitates its new polyacrylonitrile-cellulose acetate fiber from DMSO. Industry sources now report that Du Pont is testing DMSO for its orlon process and that Chemstrand plans to use DMSO for its Acrilan fibers.

▶ **Who Will Supply?**—With one major user already committed to DMSO and two others moving in that direction, an extraordinary situation exists in supply of the material.

Until June 1959, Stepan Chemical Co. (Chicago) supplied DMSO to Toyo. But this supply was cut off by an explosion at Stepan which destroyed the plant completely. Stepan has not moved to replace this plant.

Meanwhile, Crown Zellerbach (San Francisco) has completed engineering and cleared a site for a 2,500 ton/yr. DMSO plant at Bogalusa, La. Latest word from CZ reports that this plant will be completed to go on stream during the fall of 1960.

During the interim, only small plants in Germany and Sweden are known to be producing to fill fiber needs plus others such as solvent in manufacture of agricultural chemicals, ingredient in industrial cleaners and cleaner for foundry molds.

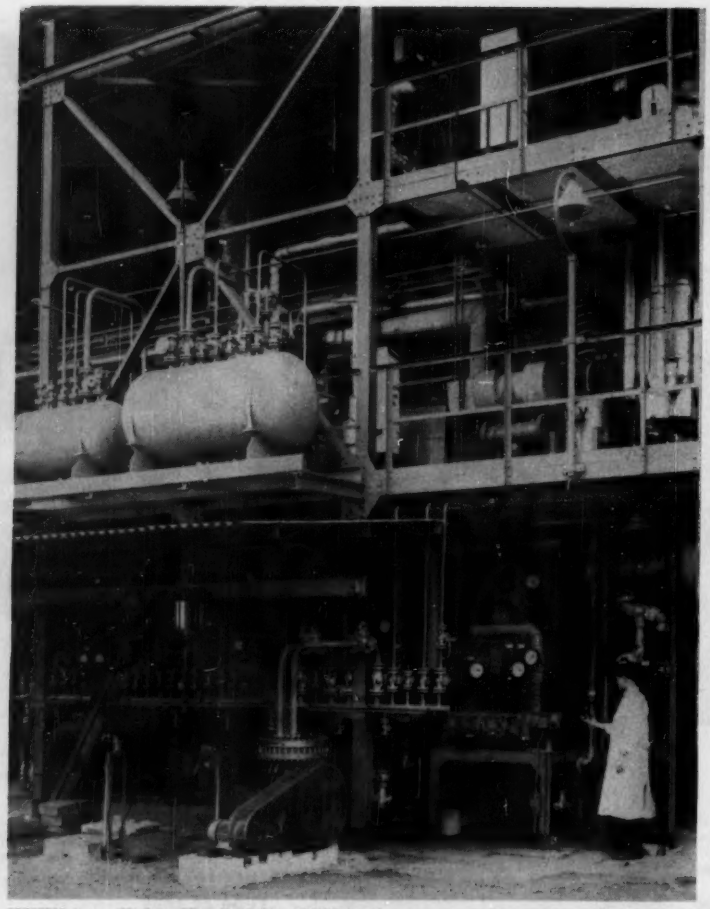
▶ **Only Three Processes**—All DMSO production, to date or planned, in four different plants is believed to be based on three known processes.

Stepan's process at Chicago is said to have been one licensed from Aktiebolaget Centrallaboratorium in Finland (U. S. 2,501,050). Carried out at 41-79 F. and atmospheric pressure, the AC process oxidizes gaseous dimethylsulfide (DMS) with oxygen in the presence of 0.32 cu. ft. NO/lb. of DMS. Temperature must not exceed 167 F.; the possibility exists that explosive gas can form.

For its Bogalusa plant, CZ has obtained exclusive U.S. and Canadian rights to a Swedish process owned by Nitroglycerin Aktiebolaget (Gyttorp). While CZ will not describe the process, a Nitroglycerin Aktiebolaget process (U. S. patent 2,702,824) is one of the known processes.

In this NA process, oxidation of DMS to DMSO takes place in a liquid phase with nitrogen oxide catalyst. Catalyst is reoxidized by air in a single step which some observers consider hazardous. However, NA has operated the process successfully.

For its supply of DMS, Boga-



VIEW into Union Kraftstoff's DMSO plant near Cologne shows oxidation vessels and pump that recycles catalyst gas back to reactor.

lusa will eventually draw from a new 5,000-ton/yr. CZ mill nearby which is licensed to use a process owned by Cellulosaforeningens Centrallaboratorium (Stockholm). Based on a feed of waste kraft pulping liquor, this process was invented by Hagglund and Enkvist.

▶**Third Now Running**—A third process (patent pending) is now on stream in a 100-ton/yr. plant at Union Rheinische Braunkohlen Kraftstoff A. G., Wesseling (Cologne). After more than a year of operation, this process is reported ready to move to larger scale as soon as demand rises.

Operating in liquid phase, Union Kraftstoff's (UK) process oxidizes DMS with NO_2 at 77-113 F. and atmospheric pressure. Used NO catalyst is tapped off, reoxidized and recycled.

According to Union Kraftstoff, its process is free of any conditions which may form explosive gases. Since the catalyst recycles, demand for NO_2 is very low. Product is free of nitrogen oxides, thus yields near 100% pure DMSO.

An added feature of UK's operation is supply of low-cost DMS produced by its own patented process (DBP 1,016,-261). In the presence of tungsten sulfide catalyst, dimethylether reacts with H_2S at 482-662 F. and 1 atm. to form DMS.

Contributing to the economy of this DMS process, says UK, is lower cost incurred to go from methanol through dimethylether to DMS than from methanol directly to DMS.

▶**React for Product**—In UK's main reactor at Wesseling, several hundred liters of DMS react at 104-122 F. with a solution of NO_2 in DMSO. During this oxidation, gaseous NO comes out of solution, being nearly insoluble in DMSO.

Passing through a stripper, the reaction mixture contacts nitrogen which removes volatile DMS; DMSO is tapped off bottom of stripper. DMS, condensed from overhead, recycles to main reactor.

▶**React for Recycle**—Noncondensed mixture of NO, N_2 and some DMS feeds into a solution of NO_2 in DMSO in a second reactor, forming more DMSO. Then all oxides of nitrogen, either liberated by reaction or held in DMSO, are oxidized separately with oxygen to NO_2 and reabsorbed in DMSO stream from second reactor to form fresh solution of NO_2 in DMSO for main reactor feed.

Concentration of NO_2 in DMSO is controlled by adding fresh DMSO. Waste gases from absorber are N_2 and O_2.

▶**Properties That Sell**—Union Kraftstoff bases its hopes for expanding to a larger scale plant on impressive properties possessed by DMSO.

Important for users is nontoxicity; it doesn't affect human skin. Melting at 65 F. and boiling at 372 F., DMSO is miscible with water and most standard organic solvents. Ignition temperature is 203 F.

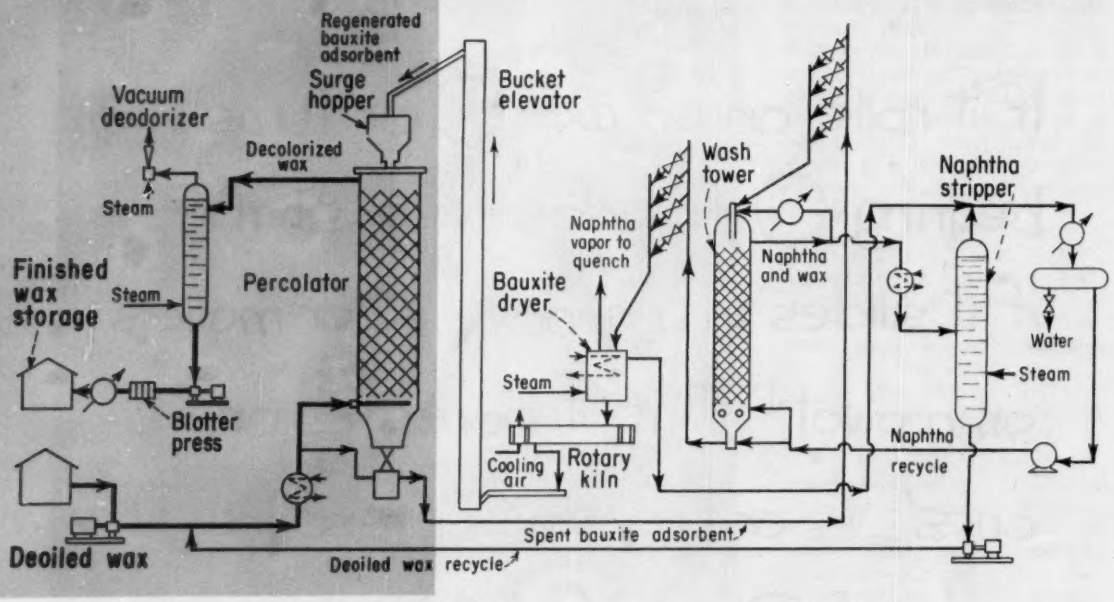
In the plastics industry, DMSO has been used as solvent for cellulose derivatives, polyvinylacetate, polyacrylic esters, PVC, and chloroprene. Spinning polyacrylonitrile with DMSO gives the fiber slightly better dye receptivity.

For epoxy varnishes, DMSO probably is the best available solvent. And it has been used successfully for textile printing.

In addition to dissolving NO_2, as it does in the UK process, DMSO also dissolves other gases such as acetylene, ethylene oxide and phenanthrene.

Processes & Technology continues on page 90.

Moving bed decolorizes feed; washing, drying and calcining restore adsorbent.



Decolorizing Swings to Continuous Basis

In a first-of-its-kind plant just starting up, moving-bed adsorption system strips color continuously from process liquid and eliminates product variations.

Among all the processes available for decolorizing its product, Western Petrochemical Corp., Chanute, Kan., feels that it has found the one which will do the most complete job.

In a pronounced switch from cyclic processes and their tendency to produce variations in product color, WPC has installed a Socony-Mobil moving-bed Thermofor Continuous Percolator (TCP) system to decolorize microcrystalline and plastic waxes.

Soon to come on stream, the TCP unit will contact brown, deoiled liquid wax countercurrently with a moving bed of bauxite adsorbent, decolorizing the wax to a 1 NPA rating, or better. At this level, product will be uniformly higher in quality than cyclically decolorized wax which has been blended to uniform quality.

►**Better for Less**—According to Socony Mobil, initial plant cost for the TCP process runs 25-35% less than a cyclic batch setup which requires multiple processing units. And the continuous operation is expected to lower operating costs by reducing labor and minimizing bauxite adsorbent losses.

While WP's gains may sound a bit too good to be true, they are substantiated by previous TCP operation. Although new to wax refining, TCP has proved itself in two European lube-oil refineries and in a large U. S. pilot plant operated by Socony. Furthermore, it has won recognition from sugar refiners with an installation at Spreckles Sugar Co., San Francisco.

►**Studied Independently**—Nonetheless, before WP chose the TCP process, the company directed its general contractor, Litwin Engineering Co., to compare the process rigorously with conventional static bed and regenerative-type processes.

Out of this study came comparative cost estimates which emphasized TCP's economic advantage. For 200 bbl./day output, estimated TCP investment was pegged at $220,000 vs. $272,500 for regenerative process and $256,000 for conventional static bed setup.

Yearly operating costs, includ-

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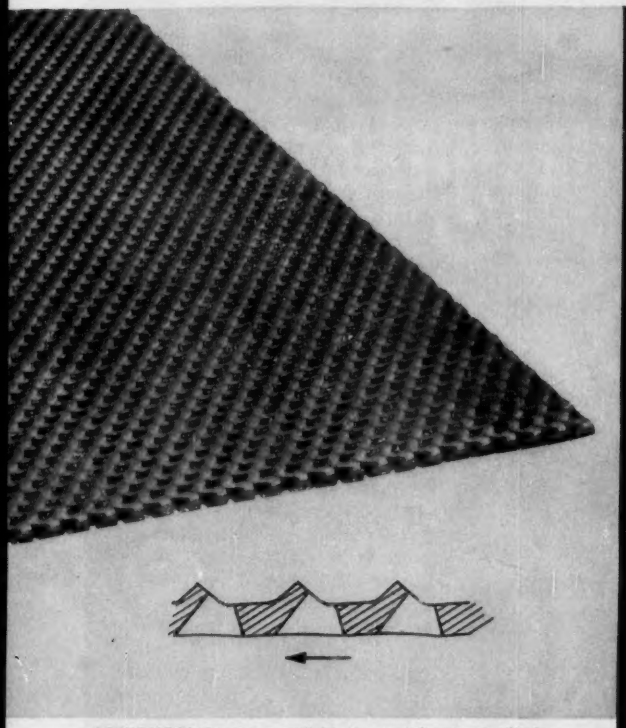
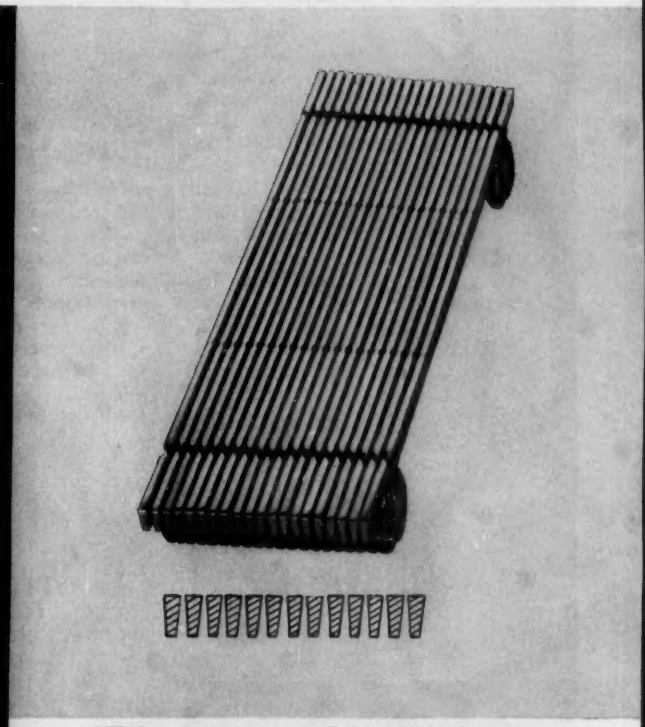
NEW CONCEPT IN SCREENING



CONIDURE* sheets are available in a complete range of hole sizes and rolled surfaces. The working side of Conidure sheets has shovel-like humps that guide material into the narrow openings, increasing screening action. The extreme taper of the hole prevents clogging or blinding.



RIMA* screens can be supplied as rectangular, oblique angled, round or oval beds. The complete range of slit widths and wire profiles accommodates a wide variety of screening and filtering operations.

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New Rima shaped-wire screens for coal, paper and food processing and water or sewage filtration have special capacity advantages over standard wedge-wire screens because of high-narrow profile wires that provide larger open area. The unique cross bar and spacing lugs keep wires uniformly separated for greater efficiency in screening.

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ing royalty payments, were placed at $60,400 for TCP, $112,000 for regenerative and $101,000 for static bed.

▶ **Basic Pattern**—Operation of the TCP system follows the basic pattern of moving-bed technology. Deoiled wax from storage passes through a heater into the bottom of the percolator. Within this unit, wax flows upward countercurrent to bauxite adsorbent bed which is moving down through the tower.

Decolorized wax flows out of percolator near the top and into a deodorizing tower where steam strips out odors under vacuum. Leaving deodorizer, wax is pumped through a blotter press and through a cooler to storage.

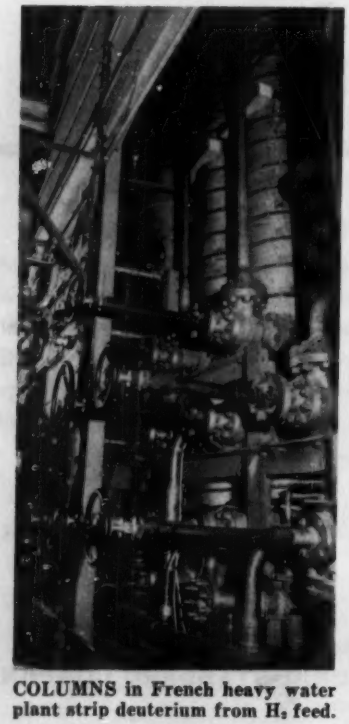
▶ **Regenerate and Recycle**—Thick, spent bauxite sludge from bottom of percolator is picked up by stream of crude liquid wax and carried to wash column. Entering at top, the spent bauxite descends against rising stream of naphtha which removes wax adhering to bauxite.

Leaving bottom of wash column, bauxite is jetted by naphtha stream into dryer for removal of naphtha prior to regeneration.

Finally, dried bauxite passes through a rotary kiln (multiple-hearth or fluid-bed kilns also are feasible) at 1,000-1,100 F. for combustion of adsorbed material and regeneration of adsorbent qualities. Discharging from the kiln, regenerated adsorbent rises through an elevator to a surge hopper which feeds decolorizing percolator.

Wash naptha and dissolved wax are separated in a stripper column. Naphtha recycles to wash column while crude wax recycles to crude wax feed tank.

Distillation of H_2 Scores Again



COLUMNS in French heavy water plant strip deuterium from H_2 feed.

France makes ready for future growth of heavy-water demand, successfully pilots its own hydrogen distillation process.

In France, hydrogen distillation has come into style for heavy-water production: Compagnie Francaise de l'Eau Lourde (CFEL) has just placed on stream the world's third successful hydrogen-distillation unit. It may also pave the way for future French H-bomb tests.

Farbwerke Hoechst pioneered the process more than two years ago with triumphant operation of its plant, using the German Linde flowsheet (*Chem. Eng.*, Feb. 23, 1959, pp. 68-72). Sulzer Bros., Winterhur, Switzerland, was second on the scene with successful operation of its pilot unit at Zurich University.

CFEL comes in third with its successful pilot unit at Toulouse, France. Unit produces but 1.5-2.0 metric tons/yr. of heavy water, not even enough to satisfy present French demand. But current estimates show that a scaled-up, 50-ton/yr. version of the unit could produce heavy water at a cost competitive with the U. S. AEC market price.

But CFEL is not planning commercialization of the new process until Europe's nuclear industry starts to build heavy-water-moderated power reactors. Present world capacity for heavy water, including the giant Savannah River plant, far exceeds demand; and construction of hydrogen distillation plants in India and Egypt only sends more coals to New Castle.

▶ **Borrowing Hydrogen Feed**—CFEL pilot unit, like other hydrogen-distillation plants now planned, abuilding or operating, is closely linked to a chemicals producer. CFEL taps ammonia producer, Office National Industrial de l'Azote (ONA), for hydrogen supply; CFEL is jointly owned by ONA and l'Air Liquide, designer of the plant.

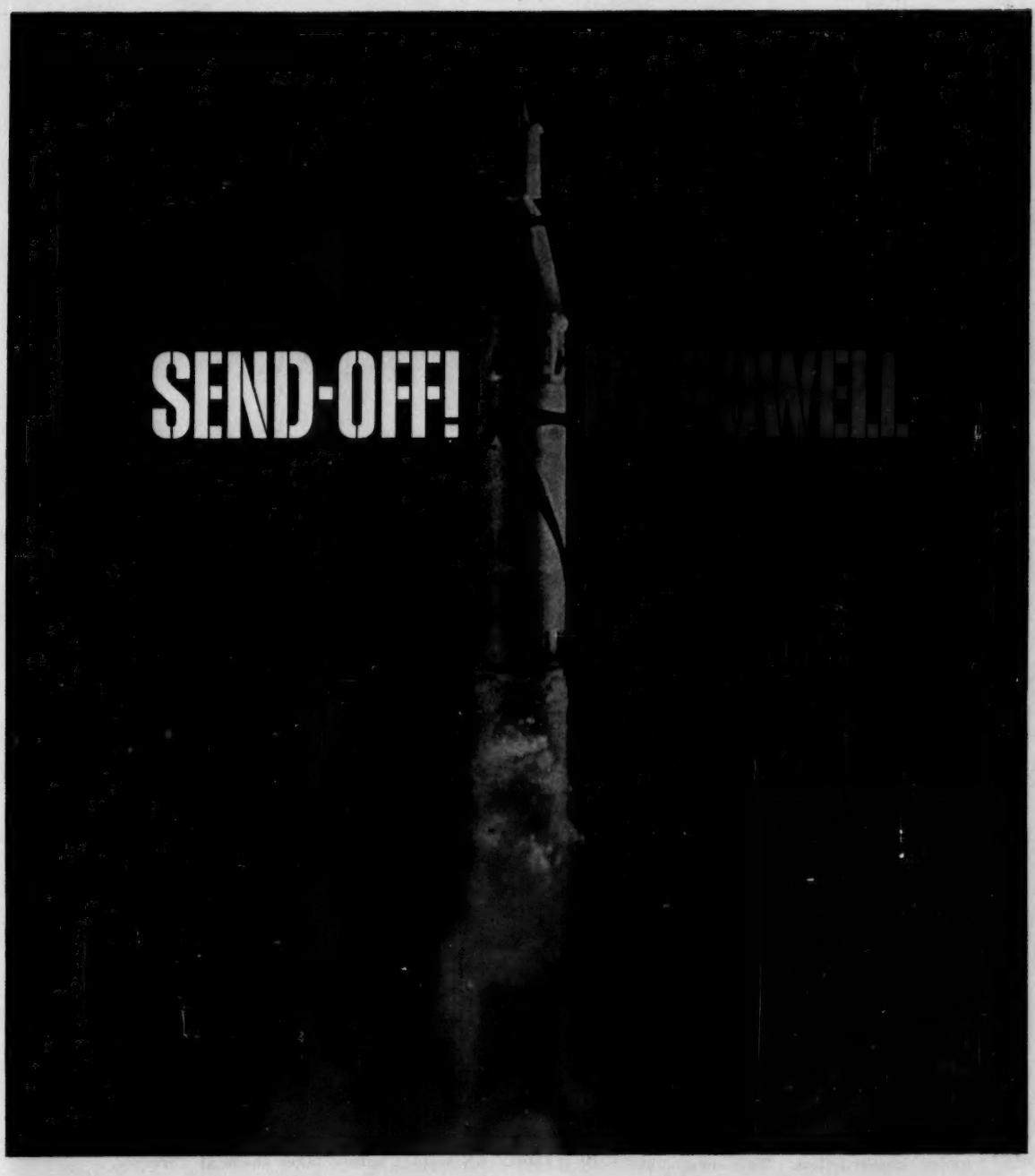
CFEL liquefies borrowed hydrogen, distills it to isolate contained deuterium (150 ppm.), and returns deuterium-depleted hydrogen to ONA for ammonia synthesis.

▶ **Only Two Columns**—l'Air Liquide's hydrogen-distillation design is based on the same principles as the German Linde design. But the French process needs only two rectification columns, while the German Linde process requires three.

In the French process, liquefied hydrogen (−423 F.) first flows to an "extraction column," which concentrates HD in liquid to 5-10%. Concentrated liquid flows to the top of a "concentrating column"; stream, tapped from the center of this column is further enriched in HD; it flows to a unit which catalytically converts HD to mixture of D_2 and H_2.

Resulting mixture flows to the bottom of the concentrating column for final enrichment to 99.8% D_2. Distillate is evaporated (−417 F.) and burned to produce D_2O.

Processes & Technology continues on page 94.



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Silkworms Help Develop Hydrogenation Catalyst

A new hydrogenation catalyst has resulted from research at Osaka University in Japan. And as unusual as the properties of the catalyst itself is the fact that it utilizes silk fibers as a carrier instead of carbon used by conventional hydrogenation catalysts.

Main interest in the new silk-palladium catalyst stems from its specific reactions to certain compounds. Aliphatic carbon-to-carbon double bonds are reduced at low temperatures in which carbonyl groups remain unattacked—making it suitable for preparing saturated aldehydes and ketones from the corresponding unsaturated compound. Although aliphatic carbonyl groups (with the exception of α-ketoglutarate) are not susceptible, aromatic carbonyl groups are attacked.

Aldehyde, nitrile and nitro groups attached to aromatic rings are catalytically hydrogenated as are azobenzene and oximino groups. A value of 14.5 kcal./mole is quoted for activation energy of hydrogenation of nitrobenzene to aniline.

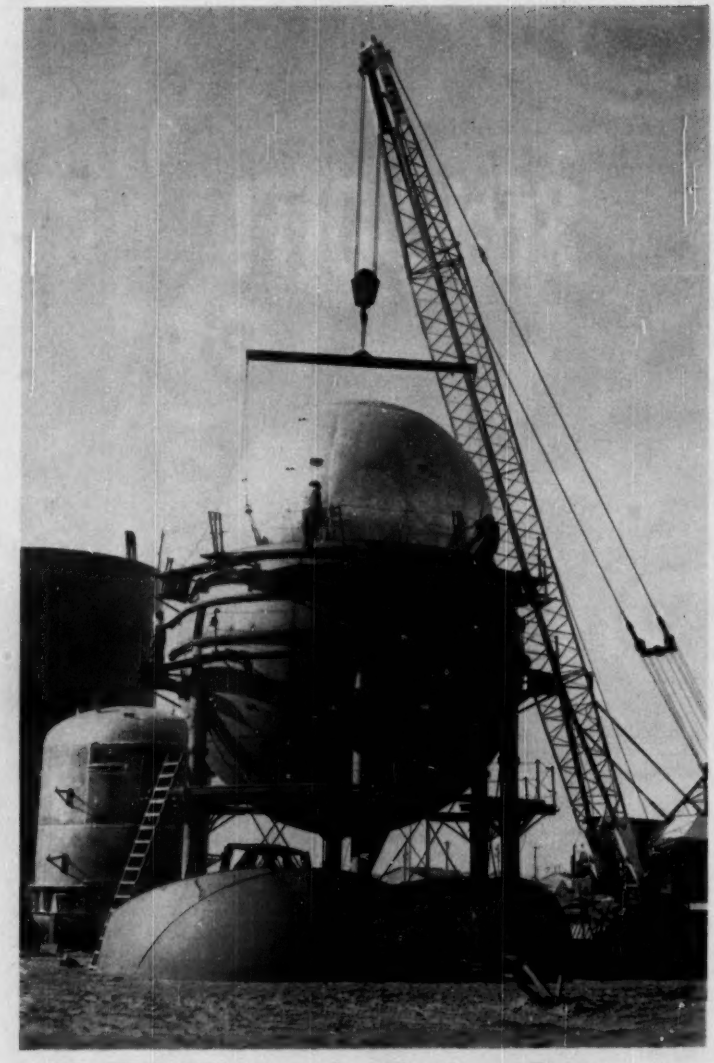
Researchers find they can obtain a 5% palladium content by boiling silk fibers in a dilute acetic acid solution of palladous chloride and then reducing with hydrogen in an autoclave.

Giant Sea Water Still Slated for Caribbean

Another giant single-unit sea water distillation plant is now under construction. This one, from the shops of Buckley and Taylor Ltd., Oldham, England, is destined for a Shell oil refinery at Cardon, Venezuela, to produce 1.2 million gal./day fresh water from the Caribbean. Process to be used: flash evaporation.

Though claimed by the English firm to be the world's largest, plant actually is topped in size by two 1.25-million-gpd. flash distillation facilities built by Westinghouse for the Shiekdom of Kuwait. (*Chem. Eng.*, Oct. 1956, p. 126.)

INDUSTRY NEWS



LIQUID HYDROGEN storage sphere takes shape at Torrance.

Linde Co. readies this huge storage sphere at Torrance, Calif., to store 13 tons of space-age, liquid hydrogen. Kaiser engineers lower the 30-ft.-dia. aluminum sphere into its spherical, carbon-steel shell and prepare to fill the space between spheres with super insulation to keep the −423 F. liquid, super cold. This and other Linde central storage spheres at Huntsville, Ala., Pittsburg, Calif., and Neosha, Mo., will serve the rocket and missile industry with liquid hydrogen fuel.

The Carborundum Co. discloses plans for a major moderniza-

Industry News continues on page 192.

MATERIAL CHARACTERISTICS	HARD TO VERY HARD	BRITTLE FRIABLE	SOFT	WET STICKY	FIBROUS
TYPE OF CRUSHER	Gyratory Hammermill One-way Reversible Impactor Jaw Single Roll	Bradmill Gyratory Hammermill One-way Reversible Impactor Jaw Single Roll	Bradmill Gyratory Hammermill One-way Reversible Impactor Jaw Single Roll	Hammermill Non-clog Single Roll Non-clog	Hammermill One-way Reversible Single Roll

HOW TO SELECT THE RIGHT CRUSHER FOR YOUR MATERIAL

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The chart above will give you a clue. The types of Pennsylvania crushers mentioned can be considered for specific applications. But materials vary considerably in physical and chemical characteristics; and type of product desired and rate of production are equally important. So more help is usually needed.

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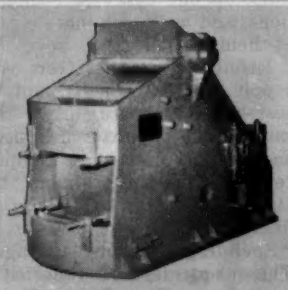
FREE BULLETINS

Just to increase your store of knowledge on crushing procedures, why-not send for our bulletin on "How To Select a Crusher." It describes the various kinds of mechanical reduction, and the types of Pennsylvania crushers that supply each one.



● Pennsylvania KUE-KEN Jaw Crusher —the crusher that employs the "crushing without rubbing" principle. Widely used for crushing a variety of materials in the chemical industries. Described in Bulletin 5012.

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BATH-BUILT

Oil: The Squeeze Comes in the '60s

Production: Costs are up; higher wellhead prices are a must.

Capital spending: With eyes on revenue, oil men are pressed to update refineries, invest in higher-profit foreign ventures.

Refining: Gasoline will bring problems—in prices and processing.

John B. Bacon, Assistant Editor

As the oil industry enters the "sanguine sixties" it surveys as many problems as opportunities.

Petroleum demand—domestic and world-wide—is sure to grow at a healthy rate. But there's growing competition from foreign oil both for energy and chemical uses.

World-wide oversupply of oil is hurting in the U.S., where high stocks and low prices depress industry activity. Much idle capital stagnates in unused producing and refining capacity. Refinery runs average less than 85% of operable capacity.

Prolific new oil finds in Algeria, Libya and the Persian Gulf will mean even hotter competition in the future.

▶ **The Squeeze Is On**—These basic pressures can't be escaped and will mount in coming years:

Producers are caught between rising costs and low prices. Crude and product imports are only part of the reason; natural gas has had equal impact. For long-term growth it's vital that domestic industry reassess its pricing policies. The table below sums up one observer's suggestions, and we'll look more closely at them later.

Refiners, too, suffer from oversupply, excess capacity and the cost-price squeeze. But they can't skimp on processing needs and product quality or competitors will step in. From this standpoint, gasoline is the refiner's biggest problem.

▶ **Spending Mirrors Change**—These squeezes are reflected in capital spending. Bigger chunks of capital outlay are being tagged for downstream processing (as opposed to crude capacity), for producing and refining abroad and for petrochemical ventures.

Outlay for refining and petrochemicals in 1960 will take 14.5% of total capital outlay, compared with 13.2% last year. By contrast, refinery crude capacity is slated to grow by only 0.3% this year, to 9.83 million bbl./day.

Spending abroad by U.S. oil men this year will run more than $1.2 billion. At least one major oil company expects that by next year foreign operations will count for 50% of its total petrochemical investment. But the pressure of foreign competition will be felt here, too. European

Production squeeze: Where will needed money come from? Higher gas prices could spell success in oil's revenue outlook.

	Domestic Wellhead Prices *				
	1938	1948	1958	1968	
Gas (¢/Mcf.)	4.9	6.5	11.9	19.0	
($/bbl.)	0.27	0.36	0.67	1.06	Price boosts must net $7.1 billion more in 1968
Oil ($/bbl.)	1.13	2.60	3.01	3.50	
Gas-liquids ($/bbl.)	0.90	3.11	2.29	2.80	

* "The Economic Outlook for the Domestic Producer," D. K. Russell, The Lehman Corp.

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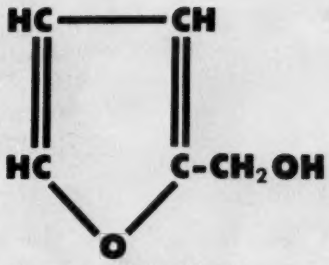
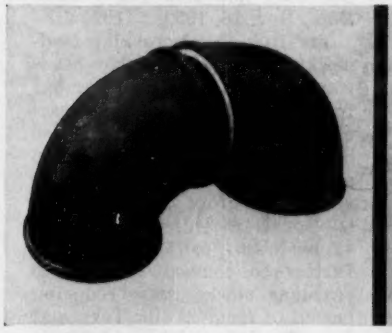
- Have low porosity
- Are inert to chemical attack
- Have high tensile strength and high heat resistance

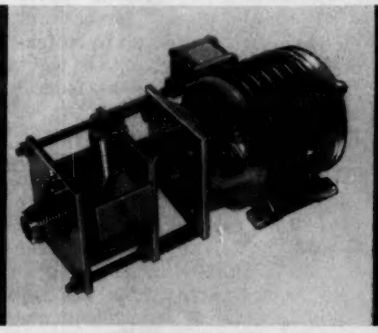


Furfuryl Alcohol

Typical Uses for FA® Resins . . .



FA resins are used to manufacture glass or asbestos reinforced acid and alkaline resistant pipe and duct.



Chemically inert vessels, valves and parts are cast of FA resin.

Room temperature setting corrosion resistant, resinous mortars are used to set tile and glazed brick exposed to chemicals or fumes.

The resins are also used as a wetting agent and binders for sand, asbestos, glass and other materials and as impregnants for porous materials.

How you can benefit

The above material represents only one area of use for FA. For information about other uses, physical data and chemistry write for Bulletin 205.

The Quaker Oats Company manufactures QO furfuryl alcohol—not FA resins.

The Quaker Oats Company
CHEMICALS DIVISION

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Chicago 54, Illinois

Room 535D, 120 Wall St.,
New York 5, N. Y.

Room 435D, 48 S.E. Hawthorne Blvd.
Portland 14, Oregon

In the United Kingdom:
Imperial Chemical Industries, Ltd., London, England

In Europe:
Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands;
Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France;
A/S "Ota", Copenhagen, S. Denmark

In Australia:
Swift & Company, Ltd., Sydney

In Japan:
F. Kanematsu & Company, Ltd., Tokyo

Spending squeeze: There's less outlay for refining capacity, more for upgrading and higher-profit foreign ventures.

	Capital Spending (million dollars) 1958	1959	1960	
Petroleum industry [1]				
Total domestic	5,300	5,200	5,200	
Refining, petrochemical	725	692	754	up 9%
Cycling plants	75	100	115	up 15%
U. S. Spending abroad [2]				
Petroleum industry	1,276	1,186	1,246	up 5%
Chemical industry	179	204	176	
European petrochemicals [3]	225	405	530	

1. Petroleum Facts and Figures, 1959 ed.; Chem. Eng. estimates. 2. McGraw-Hill Dept of Economics.. 3. Foreign capital in own country. OEEC report. Chemical Industry in Europe, 1959 ed.

countries will invest $530 million in petrochemical plants this year. Japan brought petrochemical investment last year to $240 million, and has earmarked another $160 million for new plants.

▶ **No Crying, Though**—All this is not to say that U. S. companies are losing money. Latest income statements show net domestic earnings up 20-25% from 1958. Forecasts for this year peg domestic demand up about 4.5%, crude production up 4.5% to 7,350 bbl./day, refinery runs up 3.8% to 8,280 bbl./day. Recession days are behind, but the future calls for hard work and careful planning.

▶ **Natural Gas the Key?**—Basic to the health of domestic oil industry are wellhead prices of crude oil, natural gas and gas liquids. Let's look at an analysis of these which D. K. Russell of the Lehman Corp. gave at last November's meeting of the American Petroleum Institute.

Of total petroleum energy, which in 1958 supplied 75% of the U. S.'s needs, gas provided 37%, but brought the oil industry only 14% of its wellhead revenue. So if we view gas in terms of energy, we get a vastly different view of demand growth and price needs.

Assuming prices high enough to spur activity and give needed additions to reserves, we find that in 1968 the industry will need a total wellhead revenue of $16.5 billion, or $7.1 billion more than it's getting now.

This, Russell concludes, means wellhead prices in 1968 of $3.50/bbl. for oil, 19¢/Mcf. for gas, and $2.80/bbl. for gas liquids. Gas would provide nearly 30% of the revenue increase.

For such a program to be feasible there would have to be tight import controls, and no federal regulation of gas prices.

▶ **Gas Liquids Climb**—Natural-gas liquids—a prime source of chemical feedstocks — climbed last year to a production figure of 36,730 gal./day, up 8.3% from 1958, and is due for another 4.0% rise this year.

Strongest growth in gas liquids is in liquefied petroleum gas (LPG), consisting of propane and butanes. LPG sales last year rose a whopping 16.5% to hit an annual figure of 8.7 billion gal. And 27.6% of this went to chemical manufacturers, 26.2% more than in 1958. LPG production in 1960 is slated to rise another 9.0%.

▶ **Process Changes Due**—Changes in refinery processing are developing at a fast rate. Refiners strive for the greatest product improvement for the least cost. Need to satisfy gasoline's octane and sensitivity requirements will bring these process changes:

Cracking—Not only will cat cracking capacity increase, but there will be higher throughput and better product distribution through use of improved catalysts and hydrogen treating of feedstocks. Two-stage cat cracking is already on the scene. It gives more gasoline and greater operating flexibility. California Research Corp.'s Isocracking is one example of hydrogen use to improve gasoline yields, make less coke and fuel gas (*Chem. Eng.*, Nov. 16, 1959, p. 106).

Treating of cat cracking feedstocks has made notable headway. Humble Oil & Refining has found hydrodesulfurizing of vacuum gas oils attractive, has also done work on phenol extraction of cat cracker gas oil to remove aromatics before recycling. Gulf Oil operates a high-pressure (2,000-3,000 psi.) hydrodesulfurizer to convert residues to cracking stocks, thus reducing output of residual oils. Texaco at Los Angeles, Calif., and Eagle Point, N. J., uses furfural extraction to upgrade cracking feed, extracts aromatics which yield coke and gas upon cracking.

Reforming—More cat reforming capacity is due. Processing changes can boost yield and quality here, too. Reduced reforming pressures (hence less hydrogen in feed) raises gasoline yield at constant octane number. But this gives more coke and requires regenerative operation.

It's possible to extract the aromatics from cat reformate and recycle the paraffins. This permits less severe reforming than once-through operation, with a resulting yield advantage. Octane level where this recycling becomes attractive decreases as feed paraffin content increases.

▶ **Sensitivity a Thorn**—With respect to cracking and reforming, refiners face a dilemma. For, although these processes give more octanes, they contribute to gaso-

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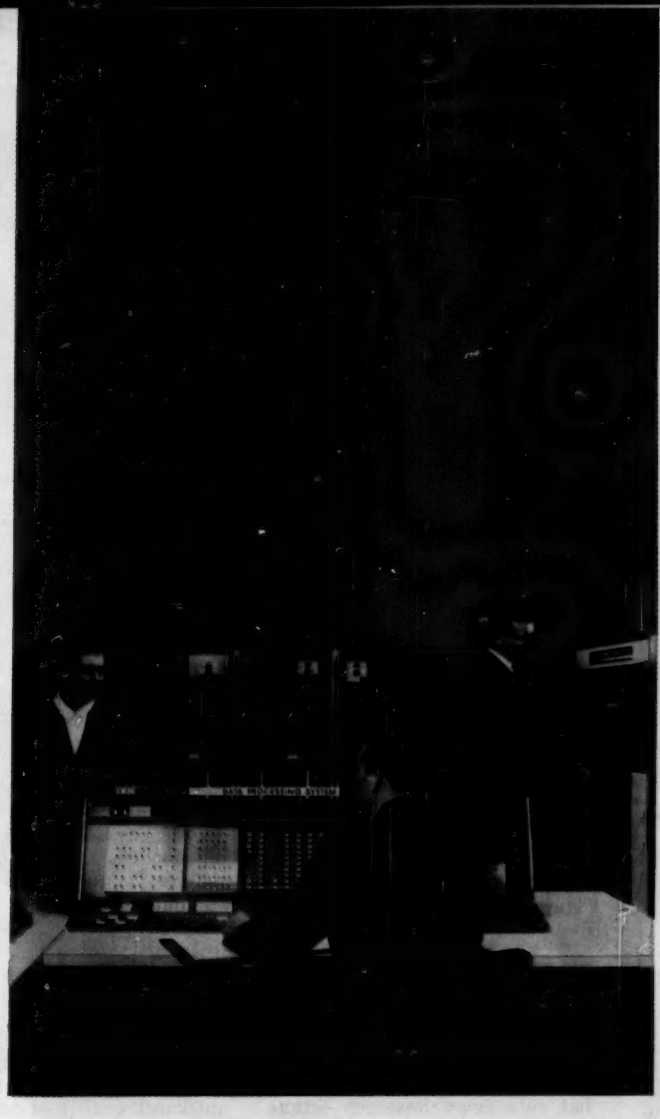

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Refining squeeze: Octane number, sensitivity call the tune. Refiners must update processes, use more blending tricks.

Gasoline Quality	1959	1960	1961	1962	1963
Pool octane number (leaded Research)	95.2	96.7	97.7	98.9	99.8
Sensitivity (Research octane no. minus motor octane no.)	9.8	....	....	....	8.0

How refiners will get octane numbers:

Cat cracking: More capacity. Better catalysts, hydrogen treating will improve gasoline yields.

Cat reforming: More capacity. Lower pressures will boost yields, but call for regenerative operation.

Alkylation: Capacity will soar. Refiners will hoard most of the butylenes and more propylene.

Isomerization: It's coming slowly. Refiners are already isomerizing some pentane. Next: hexane.

Blending tricks: Some are now in use. Split cat reformate, cat naphtha, blend heavy reformate and light naphtha. Superfractionate to get several cuts, blend in "tailor-made" gasolines. None of these boosts average pool octane.

line's sensitivity—the spread between Research octane number and motor octane number, the latter a better measure of actual performance. This spread now stands at nearly 10 octane numbers. Refiners feel it may have to be narrowed to 9 or less.

When it comes to sensitivity, olefins and aromatics — prime products of cracking and reforming—are the worst performers. Saturates are best. So refiners must contemplate cat reforming of cracked naphthas, and hydrogen treating of feedstocks. Hydrogen treating can saturate olefins and reduce sensitivity, but cuts down Research octane number in the process.

There are other routes to high-octane paraffins:

Alkylation—Capacity will see a rapid increase, with attendant demand on isobutane, butylenes and, increasingly, propylenes. Present trend is for refiners to recover as much butylenes and propylenes as possible from refinery gases.

Isomerization—There are several available processes to isomerize normal C_5-C_7's, the very-low-octane constituents of the gasoline pool. Processing is expensive, though, and it's slow in coming. Need for isobutane, however, has already led a few refiners to isomerize butane.

Recent announcement of latest work on tetramethyl lead additive may slow isomerization's advent. Use of this additive in highly aromatic gasolines is actually aimed directly at boosting antiknock quality of normal hexane and heptane.

In addition to new or already available upgrading processes, there are a number of blending tricks that refiners can use to balance gasoline blends. Blending, though, doesn't raise the over-all octane average.

Here are blending maneuvers, some now in use, that will find more work in refineries:

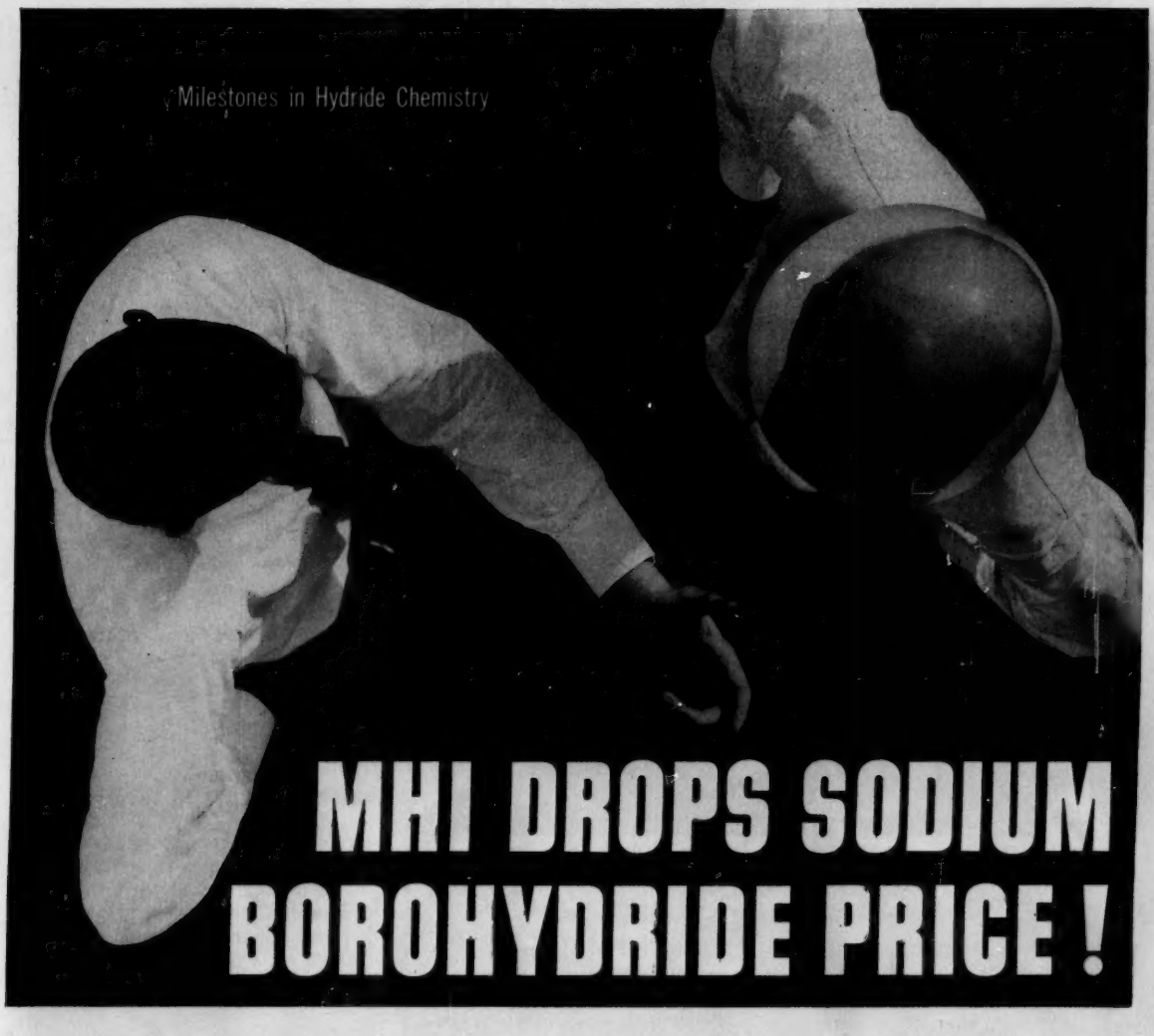
- Split catalytic reformate into light and heavy fractions. Heavy fraction (20-40% of total reformate volume) is 75-90% aromatics, the rest mostly saturates. Its leaded Research octane number is 2-6 higher than light fraction.
- Split naphtha from cat cracking to get a light fraction (30-50% of total volume) 2-4 octanes higher than the whole stream. Cat naphthas contain, typically, 25-40 vol.% olefins, about 20-25% aromatics.
- Blend heavy reformate and light cat naphtha in various ratios to get desired octane and boiling characteristics.
- Superfractionate reformate and cracked naphtha into several cuts with different octane and boiling ranges. This gives blending flexibility.

More Chemical Feedstocks Will Come From Oil

Production of Crude Products From Oil and Natural Gas (million lb./yr.)

	1958	1959	1960	1961
Ethane	639	646	710	750
Ethylene	4,149	4,500	4,800	5,050
Propane	3,019	3,415	3,700	4,000
Propylene	1,769	1,950	2,200	2,500
Butylenes	2,027	2,950	3,500	3,800

Source: U. S. Tariff Commission, Chem. Eng. estimates.



MHI DROPS SODIUM BOROHYDRIDE PRICE !

$19.90 PER POUND* is the new price for high-purity MHI sodium borohydride, in quantity lots of 5,000 pounds. This is the lowest price ever offered for 98% pure sodium borohydride powder. Increased commercial use, perfected processing techniques, and expanded production facilities have made this new price break-through possible. Remarkably stable, sodium borohydride is easily used with complete safety in standard equipment. It is shipped in polyethylene-lined, 55-gallon drums.

The new price should put sodium borohydride within the economic reach of many processors looking for a powerful, high-yield reducing agent for aldehydes, ketones, peroxides and acid chlorides. Others can now take advantage of its proven effectiveness for continuous fixed-bed, in-stream "clean up" of carbonyl or peroxides from gaseous or liquid olefins, diolefins, alcohols and glycols, amines and amino-alcohols, ethers and polyethers, acrylonitrile and chlorinated hydrocarbons. For producing better vinyl foams, sodium borohydride offers versatile and inexpensive process possibilities using simple equipment.

This new price combined with the reducing power and flexibility of sodium borohydride may well justify your immediate inquiry for complete information.

Do you have these new technical publications?
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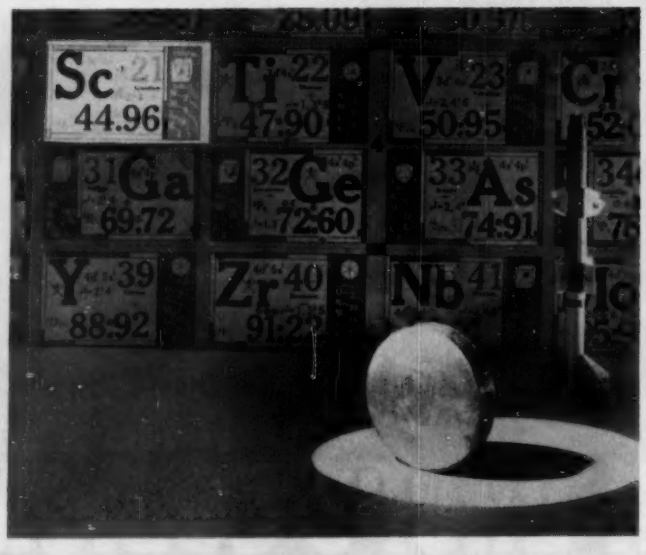


Pound of Rare Light Metal Produced for Air Force

Production of a pound of scandium, an extremely rare metal, marks the first time that such a "large" quantity of scandium ever existed in one place at one time. The material is in the form of two disks, about 3¼ in. in diameter and ¼ in. thick. It was produced by Union Carbide Metals, in accordance with an Air Force contract calling for one pound of scandium of at least 99% purity.

The Air Force is interested in scandium because it is believed to have some unique properties. Comparable to aluminum in density, it has a melting point which is considerably higher. A second contract between the Air Force and Carbide calls for an analysis of the material by the company to study its physical, chemical and mechanical properties. — Union Carbide Metals Co., New York. 102A

Flocculant

Produces better quality water at lower cost.

Immediate availability of Purifloc N17, a synthetic high purity flocculant produced especially for use in the treatment of potable water, has been announced.

Recently cleared for use in potable water by the U. S. Public Health Service, Purifloc N17 is described as a "synthetic, high molecular weight flocculant with high activity for many types of suspended solids normally found in natural waters and produced by chemical treatment."

Due to the high activity, only small quantities of Purifloc N17 are required to achieve a high degree of particle agglomeration. A concentration of 1 ppm. is recommended.

Suggested applications include use as a primary coagulant for presedimentation, conventional and high rate (sludge-blanket) water treatment plants; as a coagulant aid to enhance the activity of primary flocculants such as alum and ferric sulfate; as a coagulant or coagulant aid in chemical water softening operations to reduce the load of suspended solids to the filters; as a clarification aid to allow design of rapid sand filters to operate at double or triple conventional hydraulic rates and yet produce water of equal or better quality. —Dow Chemical Co., Midland, Mich. 102B

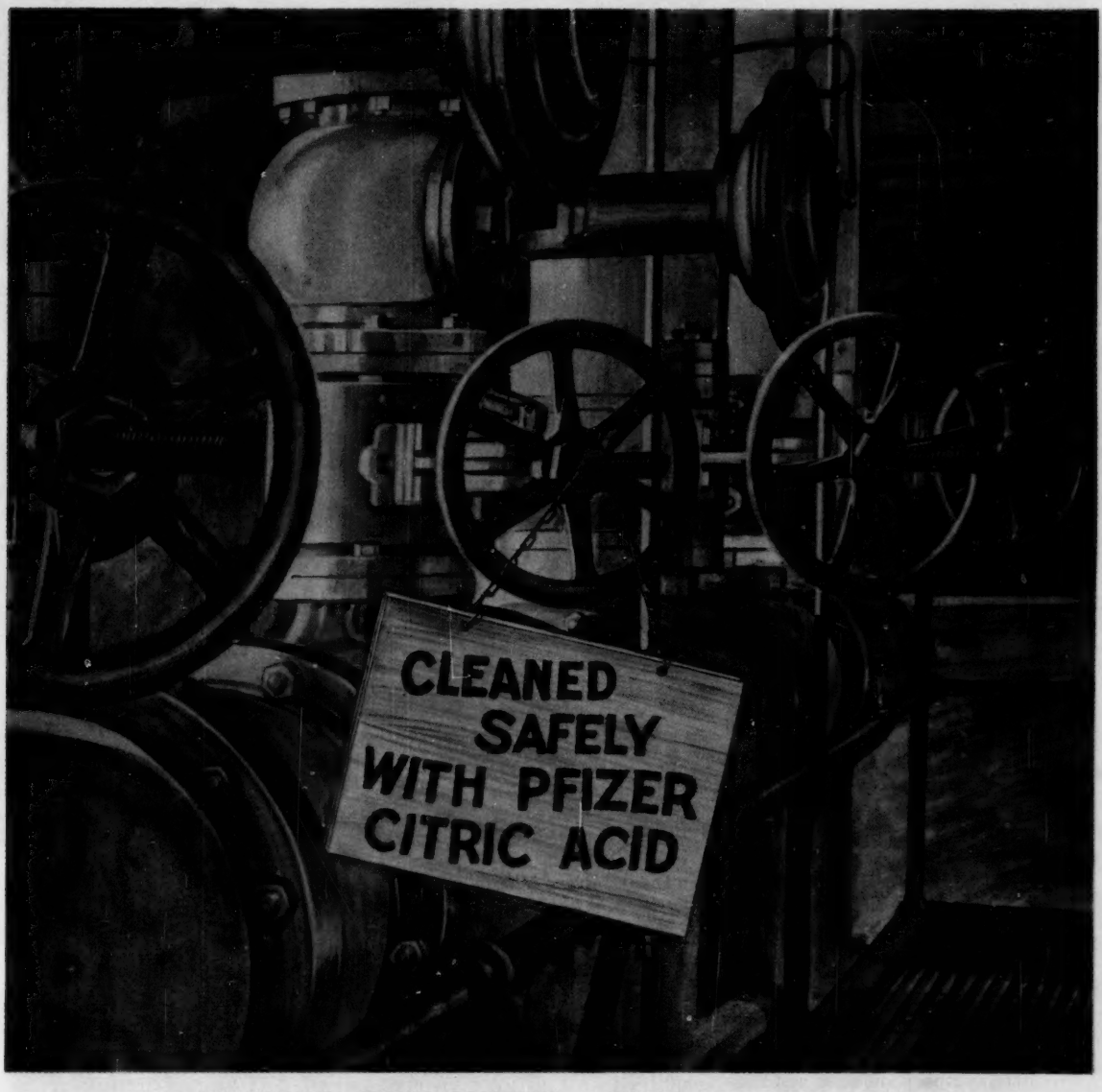
Molybdenum Disulfide

Dispersion redoubles lubrication effect in EP uses.

A new molybdenum disulfide lubricant, Molykote M-55-Plus, for extreme pressure applications—on drills, taps, cold metal forming dies, punches, and such —has been announced.

It supersedes M-55, the company's 5% EP dispersion in medium oil, and out-performs its predecessor by 116% in welding-load tests and 71% in wear resistance tests.

Molykote M-55-Plus does not derive its extreme pressure characteristics from the fusion of additives like sulfur and chlorine at elevated temperatures, as do conventional EP lubricants. It is suitable for slow moving parts under heavy loads, and for surfaces which



HEAT EXCHANGERS—ATOMIC REACTORS—CHEMICAL PROCESSING EQUIPMENT

Safe, efficient cleaning of stainless steel boilers, heat exchangers, atomic reactors, chemical processing equipment! It's assured, when chloride-free Pfizer Citric Acid is used by your chemical cleaning service company. Easier and more efficient after-rinsing is another definite plus! Check for yourself these unique advantages of using Pfizer Citric Acid:

1. Citric acid is highly efficient in removing imbedded metal and oxide films from stainless steel.
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would be reactive with additives.

The improved lubricity of M-55-Plus, and its ability to "plate itself out" on metal surfaces, recommends it also for wear reduction applications in sleeve bearings and instrument gears, even though lightly loaded.—**Alpha-Molykote Corp., Stamford, Conn.** 102C

Phenolic Resin

New material shows favorable properties for compounding with rubber.

The Plastics Division of National Polychemicals has announced the development of Poly-Phen S-218, a new phenolic resin for use in light colored compounds based on natural rubber and styrene-butadiene copolymers. The company states that Poly-Phen S-218, in comparison with resins presently on the market, will impart substantially lighter color and better color stability while also providing good reinforcement. The resin is reported to develop a high degree of hardness and stiffness in most molding compounds, without increasing the specific gravity of the vulcanizate.

National is marketing the resin as uncatalyzed flakes or powder and also as a catalyzed powder. It is recommended for use in compounding of top lifts, composition soles and miscellaneous mechanical goods.—**National Polychemicals, Inc., Wilmington, Mass.** 104A

Colloidal Silica

Keeps paint surface slick, clean by filling surface micro-pores.

A water-like fluid that possesses the unique property of making a smooth paint surface so slick that dust and dirt cannot cling to it has been successfully field tested for industrial maintenance.

Soil retardant concentrate, based on colloidal silica, is mixed one part with 14 parts water, and sprayed, brushed, roller-coated, mopped, or wiped on a clean interior or exterior painted surface as thinly as possible. Within 15 minutes a hard, transparent coating has formed that sheds dust and dirt deposited from the atmosphere. Smudges remove with ease.

In varying degrees, all surfaces possess a great number of microscopic pits and pores where dirt particles wedge themselves and resist removal. When the new retardant is applied, its clear, hard constituent particles fill these indentations.

A type of the company's colloidal silica has been used successfully for several years by one of the largest Venetian-blind manufacturers.—**Du Pont Co., Wilmington, Del.** 104B

Antibiotic

Prevents spoilage of harvested forage crops.

The active ingredient of new forage preservative, Silotracin, is zinc bacitracin, an antibiotic which is widely used as a pharmaceutical for human use, as a veterinary medicine, and as a health and growth factor in animal and poultry feeds.

Experiments at a number of agricultural colleges and experiment stations have shown that the addition of Silotracin in quantities of 5 lb./ton of silage selectively discourages the bacteria which make poor quality silage and encourages the bacterial action which preserves silage nutritional value. When the Silotracin-treated feed is taken from the silo, none of the antibiotic remains.

The zinc bacitracin antibiotic prevents damage and permits beneficial bacteria to preserve the nutritional elements in silage which nourish farm animals and increase dairy production. — **Commercial Solvents Corp., New York.** 104C

Polyester

New Class F wire enamel resists 175 C.

Latest addition to the company's Alkanex polyester line, a new insulation is believed to have the highest thermal resistance of any polyester wire enamel yet developed. Normal thermal resistance required for this type of insulation, Class F wire enamel, is about 155 C. The new enamel withstands 175 C.

Key features of the new

Newsworthy Chemicals

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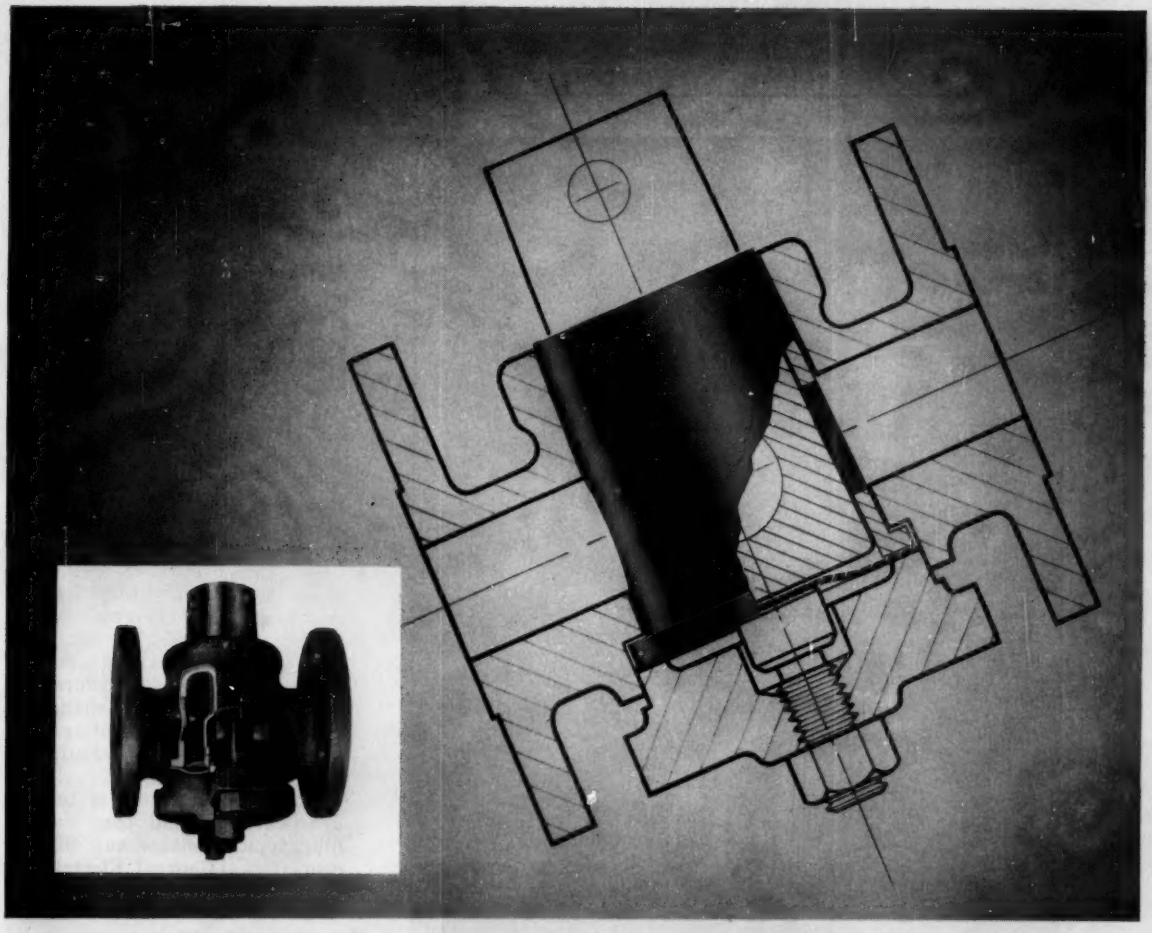

Valves using durable TFE resins turn easily, seal tight, can't "freeze"

Exceptional performance of the DURCO* plug valve shown above is assured by the use of a reinforced TEFLON TFE-fluorocarbon resin for the sleeve and diaphragm. The low-friction TFE resin eliminates the need for lubrication, thus permitting a simplified valve design and reducing maintenance problems. Problems of leakage and "freezing" are also eliminated. In one application these plug valves, handling corrosive chemicals at 270°F., have already lasted 36 times as long as valves formerly used.

Du Pont TEFLON TFE resins are rated for continuous duty up to 500°F. They are inert to virtually all chemicals and solvents. Even in cases where service conditions are not exceptionally difficult, the use of TFE resins provides increased reliability of performance and lower maintenance costs. Their unique combination of properties has made possible a variety of improvements in chemical designs and processes. For more information that will help you evaluate TFE resins for use in *your* operations, write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room T-10321, Nemours Building, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

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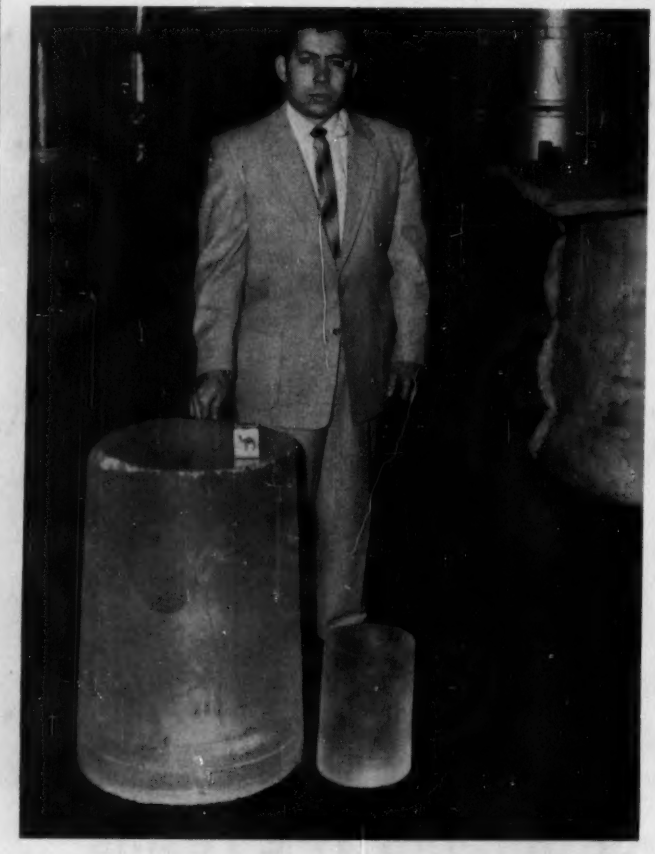
TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*



Plastic Fluors Can Detect Radiation

Plastic scintillation fluors, said to be the largest ever produced, are expected to have various applications in the field of radiation detection and measurement.

Weighing approximately 400 lb. before being machined, the fluors are composed of a styrene base with p-terphenyl and tetraphenyl butadiene. Pieces 16 in. or more in diameter and 24 in. in length can be cut from them.

They have been suggested for use in encapsulation applications, detection of high-energy (gamma) radiation, and human body counts. — Semi-Elements, Inc., Saxonburg, Pa. 106A

enamel are its excellent runability which enables it to be applied to all sizes and shapes of magnet wire, and its improved dielectric strength and Freon resistance which make it suitable for hermetic motor applications. — **General Electric Co., Schenectady, N. Y. 104D**

BRIEFS

Gloss latex paints formulated with a new vehicle, an acrylic copolymer emulsion known as U-7001 Ubatol, are being evaluated by paint manufacturers. Use of the vehicle is said to result in a hard, dry, water-resistant paint film, which retains its gloss and has no residual tack.—**UBS Chemical Co., Cambridge, Mass. 106B**

New metallic pigment binder with an unusual number of desirable properties for application printing on cotton, glass, and synthetic fibers has been announced. Called Morpatex 50, it offers prolonged resistance to dry cleaning and laundering, an unusually soft hand, good luster unaffected by pigments or organic colors.—**Morningstar-Paisley, Inc., New York. 106C**

Silicone fluids, designated XF-1030 and XF-1031, show unusual compatibility with various materials. The two new fluids are soluble in many aliphatic hydrocarbons and lower alcohols, and also form relatively stable emulsions in water with a minimum of agitation. Like conventional silicone fluids they are soluble in aromatic and chlorinated hydrocarbons, and they exhibit typical release and slip properties.—**General Electric Co., Waterford, N. Y. 106D**

Polyethylenes with appropriate built-in aromas for packaging films and molded items are now available. The scented resins, formulated by Fragrance Process Co., Inc., include such varieties as perfume, "cookie," "clean linen," chocolate and spearmint. It is claimed that the aromas can be applied to resins of any density or melt index, and that they become an integral part of the material.—**U. S. Industrial Chemicals Co., New York. 106E**

For More Information

about any item in this department, circle its code number on the

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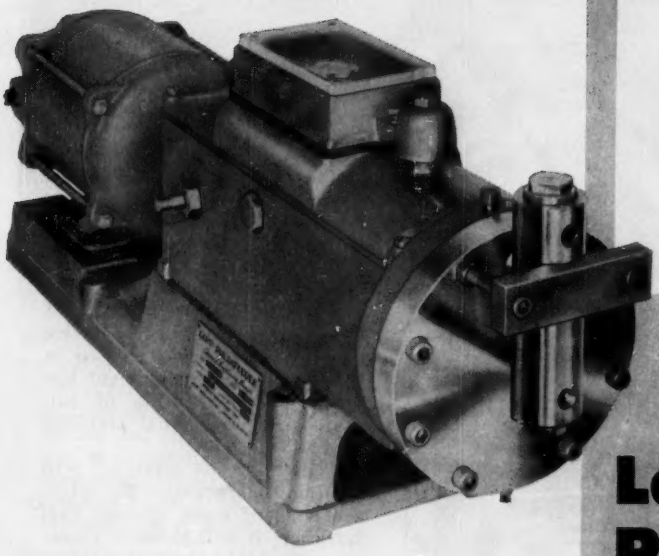
postcard (p. 221)

These fluids are difficult to meter...



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The Lapp Pulsafeeder is a highly-specialized, precision pump suited to a wide variety of special applications involving controlled-volume pumping of fluids. It's a combination piston-diaphragm pump having a hydraulically balanced diaphragm and a closed hydraulic system. The reciprocating piston action provides accuracy of positive displacement while the diaphragm isolates liquid being pumped from the pump's working parts. Eliminates need for stuffing box or running seal . . . prevents product leakage and contamination. Pumping speed is constant, variable flow results from variation in piston-stroke length . . . controlled manually by hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable. Pulsafeeder capacities range from 585 ML per hour up to 24 gpm maximum flow and pressures from minus atmospheric to 6800 psig.

Specify Lapp Pulsafeeder when you need continuous (or intermittent) pumping, at accurately controlled volume, of fluids which cannot be satisfactorily exposed to conventional pistons, cylinders and stuffing box packing. Or because of the corrosive action of chemicals and/or the need for protection of product against contamination.

Lapp

WRITE FOR BULLETIN 59 containing typical applications, flow charts, description and specifications of models of various capacities and constructions. Lapp Insulator Co., Inc., Process Equipment Division, 3616 Poplar Street, Le Roy, New York.

Built-In Damping Curbs Resonant Beam Vibration

Want to isolate process instrumentation from shock and vibration? One method may involve fabrication of the supporting panel with Rigidamp structural members. High damping characteristics are built right into these new construction materials.

At the demonstration pictured above, a typical Rigidamp cantilever beam (right) is exposed to the same vibratory forces as the conventional beam (left). Damping effectiveness of Rigidamp is apparent.

In composition, the new structures consist (see inset) of metal inserts separated from surrounding metal by thin layers of so-called "viscoelastic" damping medium.

In flexing under impressed vibration, the metal inserts tend to slide relative to the body metal; however, the "viscoelastic" medium impedes such motion and absorbs the energy of resonance as shearing strain—Barry Controls, Inc., Watertown, Mass. 108A

Oxygen Analyzer

Provides accurate data on oxygen content of gases.

Continuous operation without use of analytical chemicals, with automatic temperature compensation, but without moving parts, is characteristic of the Magnox Analyzer, a device for measurement of oxygen in gases. Yet, the instrument has an accuracy of 1-2% of full scale, and an annual stability of 1% full scale.

Typically, the analyzer will provide accurate data for determination of most efficient fuel burning; it will promote closer control of kiln atmospheres; or it will continuously measure the purity of an on-stream gaseous product with respect to oxygen. **—Milton Roy Co., Philadelphia, Pa. 108B**

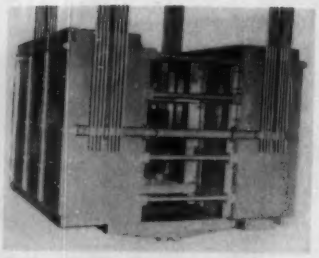
Temperature Controller

Non-indicating unit features sensitive bulb.

Suitable for direct operation of non-inductive electrically heated processes, Ekstrom Co.'s temperature controller meets the need for an economical, small, sensitive and rugged control instrument for the range 0 to 1,100 F. Control circuit runs through a snap switch rated at 15 a., 120 v. The device is also applicable to operation of electric switchgear for diversified electric loads.

Each controller has a liquid-filled, bellows-type thermal system with remote bulb, and is bimetal-compensated for temperature changes. A 1¼-in. pointer setting knob sweeps a

3-in. amplified, calibrated scale. Several design options available.—**R. A. Ekstrom Co., Harvey, Ill.** 108C

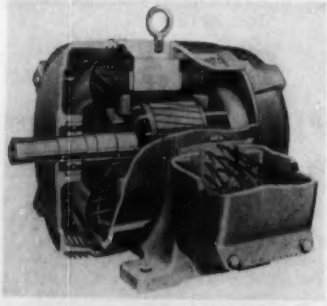


Sifter

Manufacturer's new design for harsh service.

Developed for high-capacity sifting of dry materials, Sprout-Waldron's Super Sifter features square, tubular, horizontal cross members in the structural frame. Increase in the number of these cross members permits operation of the unit under the most severe industrial requirements. Up to eight distinct separations per stack are possible.

Other features include ceiling suspension, self-balancing operation, level gyratory action and sanitary dustless operation. —**Sprout, Waldron & Co., Inc., Muncy, Pa.** 110A

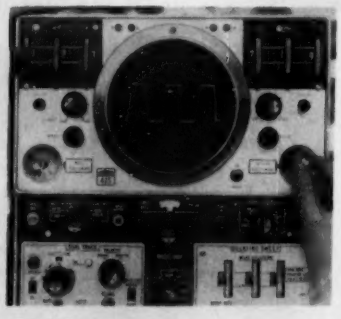


Motors

Construction assures high rotor thermal capacity.

Coming in ratings from 3 to 75 hp., a new line of squirrel-cage Life Line A motors provide high performance over a wide voltage range. Low magnetizing current assures high power factor, even at overvoltage. According to the manufacturer, high starting torque provides positive "breakaway" at low voltage under the most severe conditions of sticky loads and icing.

Both stator and rotor will handle short-time overloads. Temperature rating is 10 C. below maximum values of industry-accepted standards.—**Westinghouse Electric Corp., Pittsburgh, Pa.** 110B



Oscilloscope

High-frequency unit first with digital readout.

In addition to applications involving waveform analysis, the new DuMont 425 can be used directly as a read-in device for computers, printers, automatic process control systems and statistical production analyses. Outstanding feature of the instrument, according to the manufacturer, is the unit's digital readout, a "first" with high-frequency industrial oscilloscopes.

In operation, the digital system is relatively simple. On the face of the instrument, six thumbwheels and a joystick positioner controls traverse of two display dots across the face of the cathode-ray screen. The two dots are moved in unison by the joystick or index-positioning control. When one dot—the indexing dot—is positioned on a reference part of the waveform, the thumbwheel sets (horizontal and vertical) are used to move the second (scaling) dot to the other position on trace where measurement is to be taken.

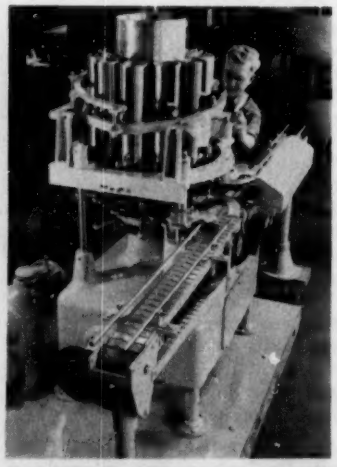
While moving the scaling dot, the thumbwheels also control the digital display, and when the two dots are positioned, the exact time and amplitude are readable directly in volts, seconds, and fractions of seconds. Dial multiplication, interpolation and parallax adjustments are unnecessary. Accuracy is 2%.—**Allen B. DuMont Labs., Inc., Clifton, N. J.** 110C

For More Information

about any item in this department, circle its code number on the

Reader Service

postcard (p. 221)



Piston Filler

Ten-station unit for glass, paper, prepack containers.

Designated Model RP-210, a new ten-station rotary piston filler operates at speeds to 300 containers/min. with an accuracy of ±0.1 fluid oz. Capable of handling products ranging from semiviscous to semisolid, the unit comes in three standard sizes: 1-8 oz./stroke, 4-16 oz./stroke and 8-38 oz./stroke.

KEMP HIGH-PRESSURE DESICCANT DRYERS

assure specified performance 2 ways!

1 Engineering

Designed to dry air and gases under pressure (ranging from 1000 to 6000 psig) to dew points of -160° F, the Kemp High-Pressure Dryer is constructed for simplicity of operation and long life. It offers the advantages of: convenient location of instruments . . . no adjustment required from zero to 100% of rated capacity . . . contamination eliminated without purging . . . uniform and complete reactivation by electric heaters located for high efficiency and durability . . . welded steel seamless towers hydrostatically tested at 50% above design pressure.

2 Experience

Supplying dry air, helium or other gases for pressurizing rocket fuel systems, conveying rocket fuel, operating servo-mechanisms, wind tunnels and instruments, the Kemp High-Pressure Dryer has proved itself at many launching stations as well as research and industrial plants. This unit's reliability of performance under all circumstances reflects Kemp's solid background in these specialized applications.

For full details on Kemp High-Pressure Desiccant Dryers or any other Kemp Dryers, contact your Kemp Representative listed in the Yellow Pages or write for Bulletins D-108, D-109.

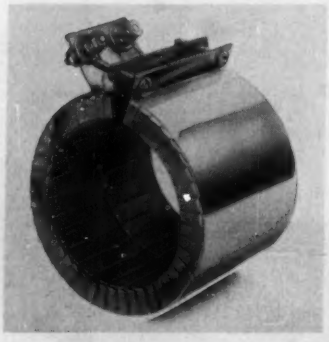
It always pays to come to

KEMP OF BALTIMORE

THE C. M. KEMP MANUFACTURING COMPANY
405 E. Oliver Street • Baltimore 2, Maryland

A special unit fills 46-oz. containers.

A single, rigid cam track controls height of fill and assures the quoted accuracy. Fill adjustment location facilitates convenient regulation of fill during the operating cycle. Chute or infeed conveyors are supplied in 4-, 6- and 8-ft. lengths.—**The Pfaudler Co., Rochester, N. Y.** **110D**



Band Heater

Radiate, rather than conduct, heat to work.

Ceramic insulated band heaters designed to meet demands for higher processing temperatures are now available in diameters from 1½ in. up, in fractional increments. Widths vary from 1 in. up by ½-in. increments. Recommended where watt densities of 40 w./sq. in. are required, the units transfer heat by radiation in contrast to conduction heaters.

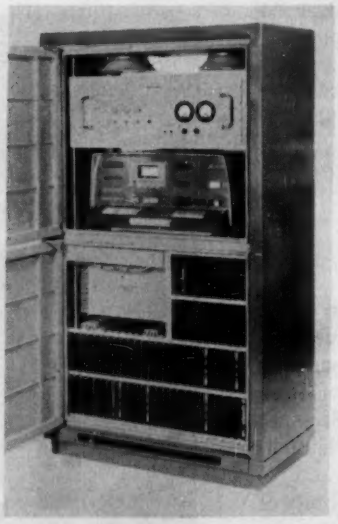
Temperature of the resistance wire is not affected by the part being heated or the manner in which the heater is installed. Pressure on the heating surface is not required. Service life reportedly exceeds 15,000 hr.—**Industrial Heater Co., Inc., New York, N. Y.** **112A**

Pipe Tape

Claims optimum properties for corrosion prevention.

Requiring no heat, tools or special skills to apply, Scotchrap pipe protection tape (No. 40) is designed for conformability over a broad temperature range, with optimum properties for pipe corrosion protection. Scotchrap also assures positive protection for joints, tees, couplings and other irregular shapes.

With a balanced high-tack adhesive system, the tape's extra internal strength stops displacement caused by movement of soil or pipe. It resists action of acids, alkalis, salts, petroleum and refined products. It is not affected by fungi or mold. Minimum application temperature is −5 F. Material of fabrication is polyvinyl chloride.—**Minnesota Mining & Mfg. Co., St. Paul, Minn.** **112B**

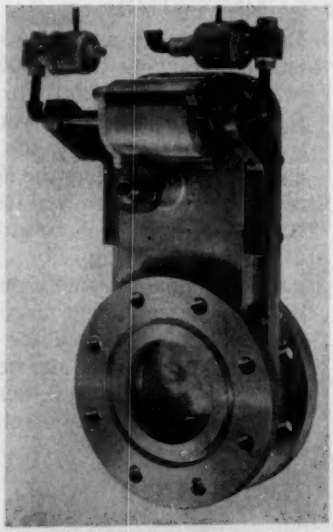


Digital Computer

To be used with marketer's control systems.

A fully transistorized digital computer, developed under a joint agreement between Leeds & Northrup and Philco, has been designed for on-line data reduction and calculation of operating guides, program control and supervisor computer control applications. Said to be one of the smallest process computers available today, the LN-3000 occupies floor space equivalent to a pair of four-drawer letter files.

Technical classification for the LN-3000 is "general-purpose serial, internal binary, fixed-point, stored-program computer." First industrial application for the unit will be at a power utility in New Jersey. There, the LN-3000 will supply performance computations and operating guides for a pair of boiler-turbine-generator units.—**Leeds & Northrup Co., Philadelphia, Pa.** **112C**



Valve Operator

Effects 180-deg. rotation of gate-valve stems.

A new air-operated control for high-vacuum gate valves features extreme compactness and very fast operation. Even in largest sizes, clearance is less than 4 in. from the valve body. Closing time is quicker than ½ sec. at line pressures.

Power transfers from piston to valve stem through a simple-rack-and-pinion. The piston is fixed; the cylinder carries the rack. Air moves the cylinder to turn the pinion gear mounted on the valve stem. Installation

EQUIPMENT NEWS
Continues on . . . Page 202

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U.S.I. CHEMICAL NEWS

March ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1960

Consumption of Heavy Chemicals Grows with U.S. Living Standard

According to statistics assembled recently by the MCA, every man, woman and child in this country in 1958 used over 46 pounds of caustic soda, 182 pounds of sulfuric acid, 41 pounds of chlorine and 44 pounds of ammonia. Per capita consumption of these basic heavy chemicals has been growing steadily since 1939, when the comparable figures were 16, 73.7, 7.9 and 7.3 pounds respectively.

MCA says that this growing consumption is a broad indication of the increasingly important part chemicals are playing in the nation's material well-being. Of course, these chemicals are not seen by the public in the form in which they are produced. But they are used in the manufacture of thousands of everyday items such as soaps and detergents, wearing apparel, paper, gasoline, and plastic articles.

Polyethylene Production In 1959 Estimated at Over a Billion Pounds

In 1959, for the first time in the history of the plastics industry, the one billion pound production mark was passed, and by two materials—polyethylene and vinyl. The Society of the Plastics Industry estimates that production of polyethylene was 1.2 billion pounds, of vinyl 1.1 billion pounds. Estimated production of either of these two raw materials in 1959 exceeded the total production of all basic plastic raw materials as recently as 1946, when only 994,277,000 pounds of plastic raw materials were produced.

As a manufacturer of polyethylene, U.S.I. has been predicting for some time that this material would be the country's first billion-pound plastic. By the end of 1959, the company's own polyethylene production capacity had reached 175 million pounds, with 125 million pounds of additional capacity scheduled to come onstream in 1960. When expansions are complete, U.S.I. will have an overall production capacity of 300 million pounds annually, and will be the second largest among all polyethylene producers.

New Acetone Data Sheet Just Released By U.S.I.

Specifications, properties, shipping information and uses for acetone are listed in a new data sheet now available from U.S.I. The material is employed widely as a solvent—for cellulose acetate, vinyl resins, fats and waxes, acetylene gas and a host of other industrial products. Acetone is also used in the manufacture of drugs, dyes and plastics, in many other organic syntheses, and as a dewaxing agent for lubricating oils.

The new data sheet can be obtained from U.S.I. sales offices or from the New York office at 99 Park Avenue.

Unique U.S.I. Pilot Plant Supplies Vinegar Makers with Technical Data and Assistance

Ethyl Alcohol Supplier U.S.I. Has Been Operating Vinegar Test Generators Since 1932; Helps Customers with Problems, Studies Production Variables, Keeps Industry Informed.

One of the large uses for industrial ethyl alcohol is in the production of vinegar—an operation which consumes ten million gallons of ethyl alcohol annually. For years, U.S.I. has provided a complete technical service for this industry at a unique pilot plant devoted entirely to the study of vinegar manufacture from ethyl alcohol.

U.S.I. does not make vinegar now, but did make it as dilute acetic acid for chemical raw materials prior to World War II. Consequently, the company has a first hand knowledge of just what kind of help its customers need to turn out the best products most efficiently and economically. U.S.I. supplies this help in three forms: basic studies of the variables in vinegar manufacture; work on customer problems; and regularly published technical news letters to the industry.

Research on Vinegar Production

Over the years a group of specialists, with a highly trained staff, has operated U.S.I.'s battery of vinegar test generators in pursuit of knowledge on such considerations as: vinegar aroma and the constituents of the raw material which contribute to it; calculations of the conversion efficiency of generators; oxygen requirements; packings; heat production and control; nutrients; acid concentrations;

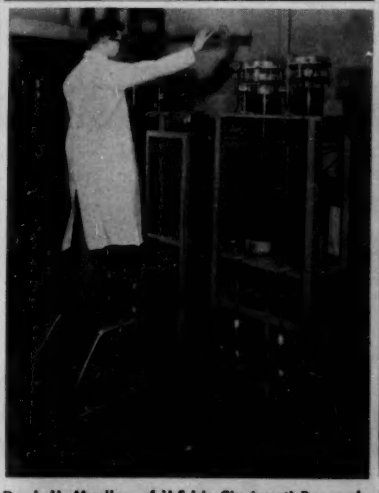
MORE

DL-*Methionine Used to Treat Chronic Peptic Ulcer*

In a 4½-year study reported recently, 54 patients with chronic peptic ulcer were treated orally with the essential sulfur amino acid, DL-methionine (3–6 grams/day) and good clinical results were obtained in 80% of the cases.

The patients treated were divided into two groups: those who received methionine preoperatively only, to see if their ulcers could be healed prior to surgery; and those who were given medical treatment with methionine to prevent or diminish the number of recurrences. Seventeen of 18 cases in the surgical group healed prior to surgery. Twenty-six of 36 cases in the medical group responded favorably. Of these, 23 with duodenal ulcers had long-term good results.

The clinical findings suggest that chronic ulcer patients undergo a kind of stress so as to lose sulfur-containing substances such as mucin. This metabolic loss can decrease resistance of the duodenal mucosa to autodigestion and lead to ulceration.



Dr. J. H. Mueller, of U.S.I.'s Cincinnati Research Laboratory, is shown putting an ethyl alcohol (SDA-35A) charge into a vinegar generator.

Dr. Mueller draws off vinegar sample from test generator in U.S.I.'s vinegar pilot plant at the Cincinnati Research Laboratory.

CONTINUED

Vinegar Pilot Plant

mineral content of waters effects of equipment; effect of alcohol denaturants; bacteriology of the process.

Vinegar News Letters

Since 1953, this research work has been reported to the vinegar industry through a series of news letters which have been issued on the average of four times a year. These news letters are comprehensive reports on matters of vital interest to the field. Not only do they concern themselves with data developed at the U.S.I. pilot plant, but they also present reviews of published data, patents and foreign developments. In 1958, one of these news letters gave a comprehensive report on happenings at the International Vinegar Conference.

Customer Service on Vinegar

U.S.I. customers come to this fully equipped, fully staffed vinegar pilot plant with their production problems. When a manufacturer's yield has dropped off, and he wants to determine the causes and correction, a U.S.I. technician from the research lab will call, when requested, and make a full examination of the problem. After studying similar conditions in the pilot generators U.S.I. can then recommend certain solutions to the problem.

This unique pilot operation was originally headquarters at Baltimore, Maryland, but was moved about a year ago to join other U.S.I. test facilities at the Central Research Laboratories at Cincinnati, Ohio. More complete information on its activities may be obtained from U.S.I., 99 Park Avenue, New York 16, N. Y., on request.

Recent Study Determines Rate at Which Undesirable Biuret Forms from Urea

The rate of biuret formation from urea under various conditions was determined in a recent study undertaken to help fertilizer formulators control the presence of this harmful chemical. Biuret, one of the main by-products obtained on heating urea, has a detrimental action on plants and leaves. It is therefore desirable to be able to estimate the rate of its formation from urea under manufacturing and shipping conditions.

The study, made by U. S. I.'s Roderick Shen and published in Agricultural & Food Chemistry, permitted determination of the constants of biuret formation from urea at different temperatures. By use of such constants, the rate of biuret formation from urea solutions at different concentrations can be calculated for any temperature. Results have been put in the form of tables and graphs. Further information may be obtained from U. S. I.

Sodium Reduction Route to Thorium Reported to Give Very High Purity Product

The U. S. Bureau of Mines has developed a new route to thorium which yields the metal at 99.8% purity, with an oxygen content of 200-500 ppm. The process utilizes sodium reduction of the chloride, which was one of the first techniques tried over a century ago when thorium was discovered. At that time, however, it was discarded because it produced a powder with over 3% oxygen content.

New technology on the effective application of alkali metals as reducing agents has brought the process back into use. The modern sodium reduction process not only yields a purer product than the 100-year-old version, but also gives a sponge rather than a powder. This cuts down on handling problems and fire hazard.

By the new method, thorium nitrate is converted to the oxalate with oxalic acid. The oxalate is then reacted with carbon tetrachloride to yield thorium tetrachloride, which is purified by distillation in nickel equipment.

Reaction of the chloride with metallic sodium is carried out in a titanium crucible under an inert atmosphere, by heating to 350-400°C. at the start and then raising the temperature to 850°C. When reaction is completed, the crucible is evacuated. Excess sodium and sodium chloride are distilled off at 900°C. under high vacuum, and the high-purity thorium sponge is recovered for vacuum arc melting to ingots.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

3,000 Assayed biochemicals for research are described in new reference guide. Sections cover amino acids, peptides, alkaloids, reagents, carbohydrates, enzymes, hormones, purines, pyrimidines, proteins, vitamins, other products. **No. 1570**

n-Butyl myristate (BUMYR) is subject of recent technical bulletin. Material is said to resemble low-viscosity natural oils but without their objectionable characteristics. Suggested for drugs, cosmetics, toiletries. **No. 1571**

Carbon-14 labeled compounds listed in new, 46-page catalog. Includes licensing information, purity methods, other pertinent data. Offers many license-exempt packages. Has special list of hydrocarbons. **No. 1572**

New atmospheric-particle counter now on market said to be designed for continuous monitoring of outdoor or indoor atmosphere. Includes strip-chart recorder, alarm system. Counting rate is 1,000 particles per minute. **No. 1573**

Molybdenum metal is discussed in new, illustrated brochure which includes general description, processing, properties, table of molybdenum products and their uses, wire conversion chart and resistance-temperature chart **No. 1574**

Thioacetamide as analytical reagent is subject of new technical booklet. Material used to precipitate metal sulfides by "precipitation from homogeneous solution." Avoids handling of hydrogen sulfide. Reaction mechanism discussed. **No. 1575**

Sodium-potassium alloys (NaK) and potassium covered in 8-page brochure now available. Details, chemistry, properties, and uses of NaK as heat exchanger fluid in atomic reactors or high temperature processes. **No. 1576**

Cationic chemicals as conditioners for hygroscopic salts and fertilizers are described in new booklet. Formulations, methods of application, recommended uses are included. Field test results with fertilizers also given. **No. 1577**

Detackifier for rubber, said to be widely used in Europe, now being made here in commercial quantities. Used as dip or spray solution. Coats uncured rubber stocks within stable film which prevents adhesion. **No. 1578**

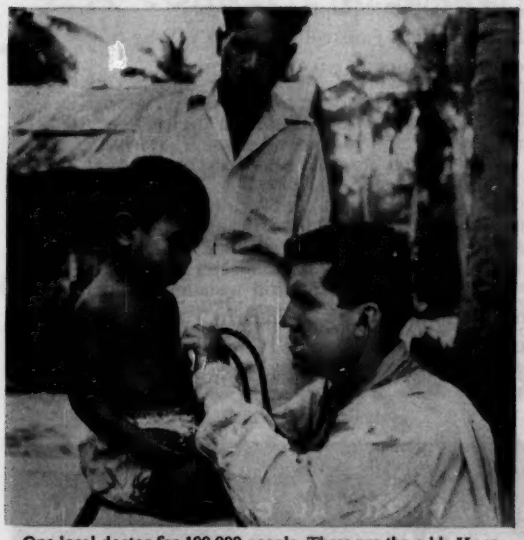
Polyethylene bottle-cardboard carton pack now being used for reagent chemicals. Bottle cap is replaced by pour-spout cap plus tubing and clamp. Carton is inverted and package becomes dispenser. When empty, pack is disposable. **No. 1579**

OFFICIAL UNITED STATES NAVY PHOTOGRAPH

This great seaborne health center will carry a new kind of aid abroad—*with your help*. Part of the people-to-people project Hope, it will enlist 200 specialists in sharing our health skills.

Ambassador with a blackboard, the Hope specialist will help the often woefully few local medical technicians train helpers. The result: many more hands. And that means one Hope dollar is multiplied many times over.

YOUR HELP CAN COME BACK A HUNDRED TIMES OVER



One local doctor for 100,000 people. These are the odds Hope may face. Yet Hope can mean so much. The health of this child. The health of five Indonesians. *Trained* hands and only a dollar's worth of penicillin can cure them of crippling yaws.

If enough of us help, the S.S. Hope will be outbound in 1960. First port of call: Indonesia. A bold health project called Hope will be underway.

The need is crucial. Many places, too many health hazards exist. Too many people robbed of the will to live. Too few hands to help. Often, a doctor for 100,000.

Hope's approach is *practical*. Help where a nation's doctors ask help. Help them help themselves to health. By training, upgrade skills—multiply hands. Hope's doctors, dentists, nurses, and technicians will man a center complete to 300-bed mobile unit and portable TV.

You can not only make every dollar do the work of many, you can earn a priceless dividend. With health comes self-respect. People at peace with themselves are less likely to war with others.

Hope is *yours* to give. It's a people-to-people project. For one year's worth, 3½ million Americans must give a dollar. Don't wait to be asked. Mail a dollar or more now to HOPE, Box 9808, Washington 15, D.C.

ADVERTISING COUNCIL PUBLIC SERVICE

HELP. LAUNCH HOPE

For ACIDPROOF EQUIPMENT

...made from tantalum for immunity (not just resistance) to most of the damaging corrosives used in processing. Fansteel acidproof tantalum equipment cuts maintenance and assures continuous production in the manufacture of acids and heavy chemicals. Tantalum equipment also eliminates costly contamination and undesirable side reactions in fine chemicals, foods and pharmaceuticals processing.

FROM STOCK

BAYONET HEATERS

Single Tube

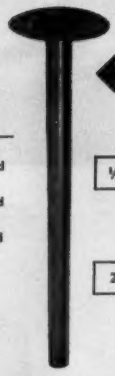
Length	Diameter
18"	1"
30"	1½"
48"	1½"
60"	1½"

Three-Tube

Length	Diameter
69"	1½"

TAPERED CONDENSERS

Length	Diameter
36"	3"-wide end 2"-narrow end
60"	6"-wide end 2"-narrow end
60"	8"-wide end 4"-narrow end



THERMOWELLS

Stocked Tubing I.D.:

½"	¾"	⅞"	1"	1¼"

Stocked Flange O.D.:

2"	2⅞"	3⅝"	5"	6¾"

Or MADE-TO-ORDER

TO YOUR SPECIFICATIONS

. . . in the form of heat exchangers, coil and "U" type heaters, special types and other sizes of bayonet heaters, tapered condensers and thermowells and other equipment for processes involving almost any corrosive material. Wherever possible, stock tantalum equipment is incorporated in the equipment design. Fansteel engineers will be glad to work out a solution to your particular corrosion problem with tantalum equipment specially designed for the job . . . and will also assist in installation, if desired.

Call FANSTEEL

...the oldest and largest manufacturer of acidproof tantalum equipment; the only supplier of tantalum equipment who works from the ore to fabricate the finest corrosion control equipment available today.

For confidential, no-obligation assistance and recommendations, call in your nearby Fansteel representative or send all details to Chemical Equipment Department, Metals and Fabrication Division.

G602

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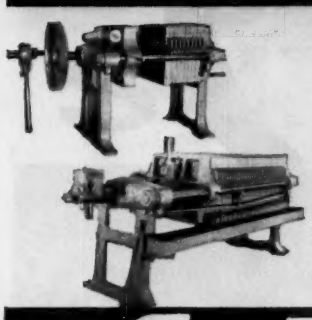
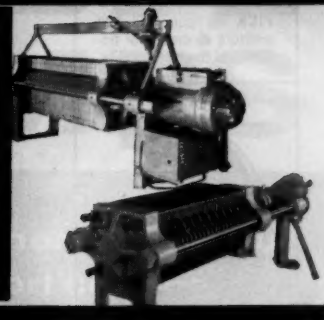
North Chicago, Illinois, U.S.A.

THIS IS sperry total filtration





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. . . Geared to the filtration needs of all industry!

In its Batavia (Ill.) and Yonkers (NY) laboratories, a staff of Sperry specialists are actively engaged in technical service and filtration research. A large backlog of Sperry experience stands by for directional guidance.

From this firm footing comes the engineering that distinguishes the entire Sperry line. SPERRY FILTER PRESSES: All styles and sizes, with center, side or corner feed; open or closed delivery; simple or thorough washing; high or low temperature controls. SPERRY CLOSING DEVICES: In 8 models including the hand operated HANDRAULIC and popular EHC-L Electric models. SPERRY FILTER MEDIA: All types, all sizes, all material. Plain or punched to your specifications.

This is Sperry Total Filtration. Broad in scope, specific in application. Put it to work on the solution of your particular filtration problem. Write today. Or mail coupon for your free Sperry catalog.

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Replace Complete Trim Without Removing Valve From Line!

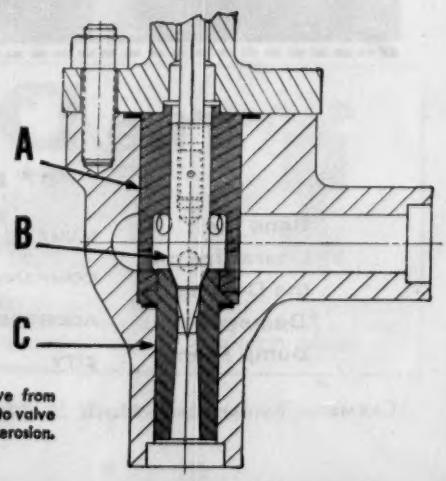
Rockwell-built Republic V-10 valves with Quick-change Trim save many hours of downtime on severe energy conversion applications with pressure drops up to 3500 lbs.

The Republic V-10 angle valve for high-pressure liquid or steam regulating services offers unique valve maintenance advantages because of its Quick-change Trim construction.

Quick-change Trim in the V-10 valve makes it possible for you to replace the valve seat, inner valve and guide in little more time than is required to dismantle and reassemble a bolted joint. No time is required for lapping the seating surfaces of the valve, since this is done in advance. *And you can make this quick trim change in minutes without removing valve from the line.* The savings to you are considerable in downtime and maintenance expense.

Republic V-10 Valves are available with either welded seat or replaceable seat, in addition to the Quick-change Trim design, with bolted or pressure seal bonnets. V-10 valve contours are designed to produce not only the desired regulating characteristics, but also to reduce erosion damage and noise as well. Precise manufacture and long-life materials make Republic regulating valves perform better, last longer, with less maintenance. For additional information, contact your nearest Republic Representative, or write to Republic Flow Meters Company, 2240 Diversey Parkway, Chicago 47, Illinois. In Canada: Republic Flow Meters Canada, Ltd., Toronto. Subsidiary of Rockwell Manufacturing Company.

Rockwell-Republic V-10 regulating valve with Type J-1 positioner is designed for rugged high-pressure liquid or steam service.



Quick-change Trim feature makes it possible to replace the seat guide (A), inner valve (B), and seat (C), without removing valve from the line. Seat extends to valve outlet to prevent body erosion.

REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL

TOUGH MATERIAL SPECIALIST—

The Model 12B Michigan

CHROME and CARBORUNDUM ORE are unloaded fast by this 16 cu ft Model 12B. Owner: New York Central RR. Location: Jersey City.

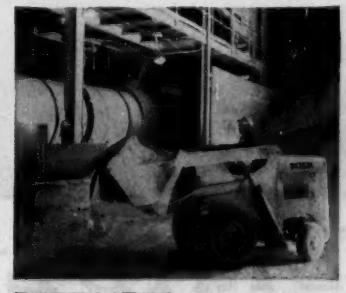
Like all Michigans, the 12B has efficient all-Clark power train, including power-shift transmission, torque converter, planetary-wheel drive axle.

BROKEN GLASS reclaiming is the prime use of this Michigan Model 12B owned by Fairmount Glass Works, Indianapolis, Indiana.

BROKEN TILE, 400 tons per 8 hour day—that's the output of the two 12B's owned by Oconee Clay Products Co., Milledgeville, Georgia.

DOLOMITE, charged directly into red-hot open hearths, is this Michigan's tough, but successful assignment in this Illinois steel plant.

COKE, used by American Brake Shoe Co, Buffalo, is dumped into hopper. Note cramped quarters easily negotiated by the Model 12B.



FERTILIZER, tight-packed and hard to dig, yields to powerful Virginia-owned Model 12B. Note the heaped bucket, a "trademark" of all Michigans.

Your "tough jobs," too, are made to order for Michigan Tractor Shovels. Model 12B capacity is 3,000 lbs, buckets are available to carry from 6 to 27 cubic feet. Write for details.

Michigan is a registered trademark of

CLARK EQUIPMENT COMPANY
Construction Machinery Division

CLARK EQUIPMENT

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FACT: For most elements, Autrometer analysis is up to 50 times faster than wet chemical methods.

FACT: Substantial economies realized in three important phases of production.

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Complete technical information including performance curves on a wide variety of materials is available on request. A Norelco representative will be pleased to furnish pertinent data upon which an Autrometer evaluation can be made for your production facility. *Write Today.*

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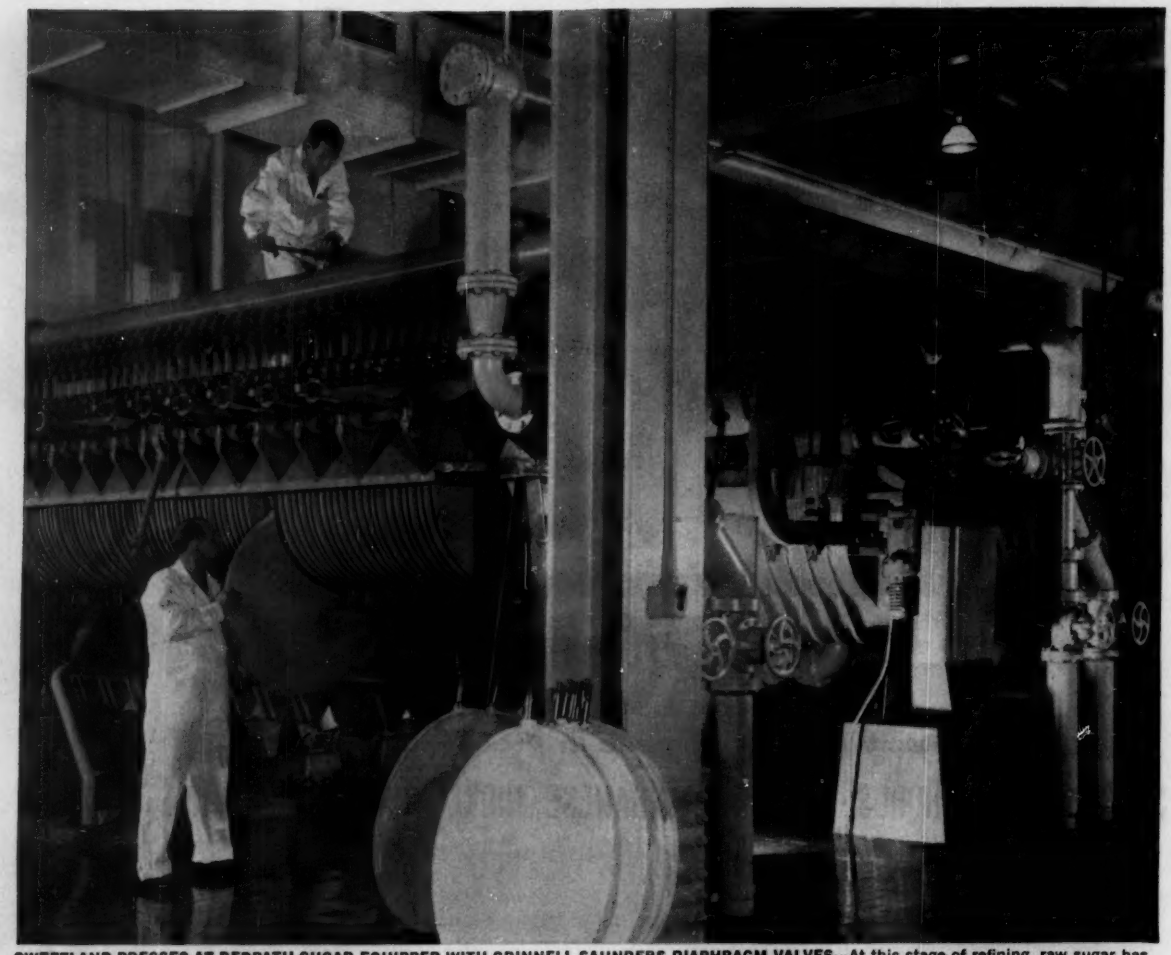


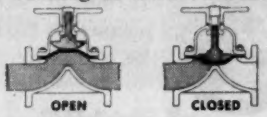
SWEETLAND PRESSES AT REDPATH SUGAR EQUIPPED WITH GRINNELL-SAUNDERS DIAPHRAGM VALVES—At this stage of refining, raw sugar has already been washed, dissolved, mixed with lime — and the lime and impurities in sugar precipitated with carbon dioxide gas. The resultant mixture is filtered through the Sweetland press to remove precipitant. Workmen are shown replacing the leaves in one of the Redpath Sweetlands.

Keeps sugar crystals from abrading working mechanism, avoids valve sticking, and prevents product leakage

A big problem in refining sugar is to prevent damage to the working mechanism of the usual type of valve by the eroding action of sugar crystals. Failure to do this means that sooner or later valves won't close tightly — resulting in messy, unsanitary, costly-to-repair leaks.

At Canada and Dominion Sugar Company's Redpath Refinery, in Toronto, Canada, Grinnell-Saunders Diaphragm Valves help avoid these problems. The diaphragm separates working parts from the fluid stream — preventing erosion of valve mechanisms on the one hand, and sticky or "frozen" valves on the other.

Grinnell-Saunders Diaphragm Valves are available in a wide range of body, lining and diaphragm materials. For more details, see Grinnell's insert in Chemical Engineering Catalog or Sweet's Plant Engineering File — or communicate with the Grinnell Company.



GRINNELL-SAUNDERS DIAPHRAGM VALVES

GRINNELL COMPANY, PROVIDENCE 1, R. I. • BRANCH WAREHOUSES AND DISTRIBUTORS FROM COAST TO COAST
PIPE FITTINGS • VALVES • PIPE HANGERS • PREFABRICATED PIPING • UNIT HEATERS • PIPING SPECIALTIES

...another reason why Timken® stainless steel tubing gives you more for your money

WHEN you need stainless steel pressure tubing for high temperature and pressure applications, take this wise step: Specify Timken® stainless pressure tubing. You will be sure of getting the finest quality available. One reason: Timken steel quality begins in our own melt shop. Another, our tubing gets "the white glove treatment" thru all manufacturing operations. For example, during white pickling, shown above, stainless steel straps hold the tubes to prevent damaging the surface. Excellent surface finish and high internal quality are assured in Timken stainless tubing because:

1. THE TIMKEN SEAMLESS tube mills are among the most modern and best-equipped anywhere.

2. WE PIONEERED the production of stainless steel tubing for pressure tube applications, and have developed numerous stainless and intermediate alloy steels for this purpose.

3. SPECIAL TECHNIQUES, some of them unique in the steel industry, are used in producing Timken stainless pressure tubing.

Call in Timken Company metallurgical experts to help solve your stainless pressure tubing problems. And there's a wide variety of sizes and grades of tubing —some not available anywhere else. For the most for your money in steel, specify "Timken". The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

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1. Quality that's uniform from heat to heat, bar to bar, order to order
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TIMKEN ALLOY STEEL AND SEAMLESS TUBING IS AVAILABLE FROM STEEL SERVICE CENTERS IN 44 CITIES IN THE UNITED STATES

HYPALON® pump linings outlast hard rubber 8-to-1 in caustic soda-chlorine unit

HYPALON-lined impellers and pump casings in the caustic soda-chlorine unit of a leading chemical manufacturer have been on the job since December, 1957. Previously hard rubber had been used. These needed replacement after only a few months of service.

Three solutions are handled in this chemical operation, each in separate pumps: 13% sodium hypochlorite up to 150° F.; 30% sodium chloride up to 150° F.; 37% hydrochloric acid up to 180° F.

The HYPALON-lined parts are carefully examined during periodic inspections of the pumps. To date, there has been no evidence of chemical attack—after more than 26 months of continuous service.

HYPALON is resistant to corrosive chemicals, abrasion, ozone, sunlight, weather, high temperature (see chart). All this—plus its flame resistance and permanent colorability—make it an extremely versatile elastomer. Rubber maintenance products which offer long-term economy of HYPALON and neoprene are available from your rubber goods distributor. He can suggest the right product for any job.

E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department CE-3, Wilmington 98, Delaware.

PROPERTIES OF HYPALON

Hardness Range..40-95 Shore A
Tensile Strength..Over 3000 psi
Temperature Range
–80° F. to 350° F.
Adhesion to Fabrics.....Good
Adhesion to Metals...Excellent
Chemical Resistance
Good to Excellent
Ozone Resistance..Outstanding
Flame Resistance .....Good
Sunlight and Weather
Resistance .....Outstanding
Abrasion Resistance..Excellent
Oil Resistance
Good to Excellent

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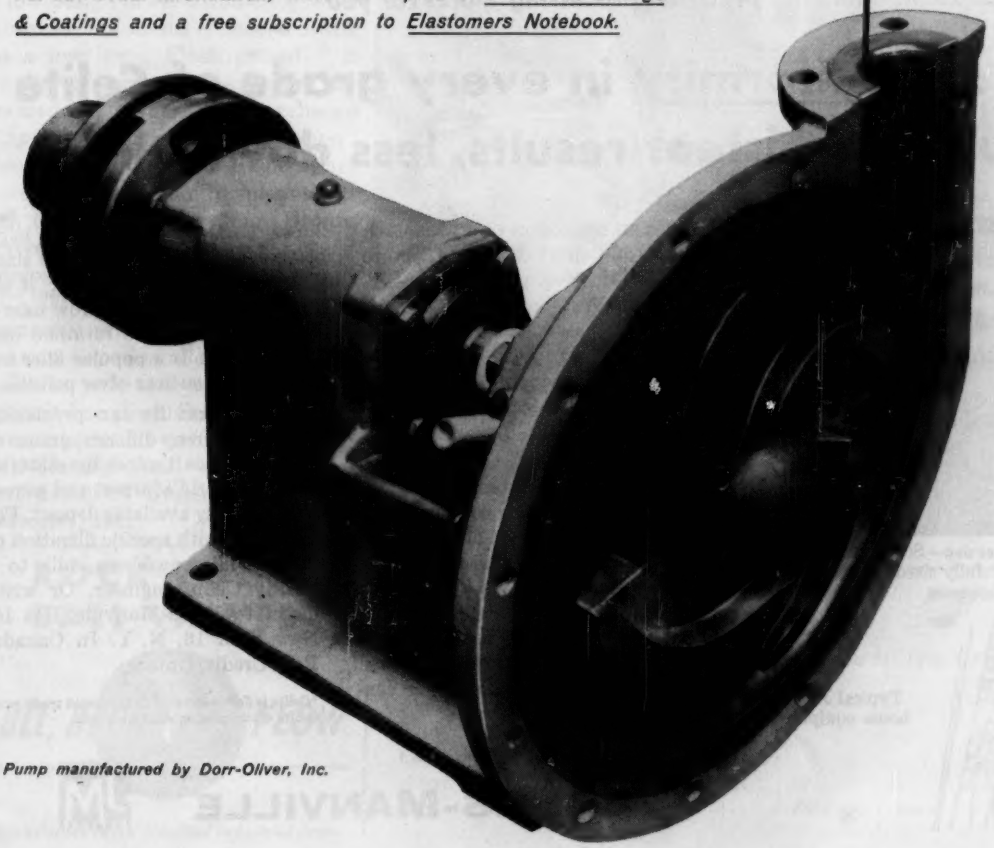
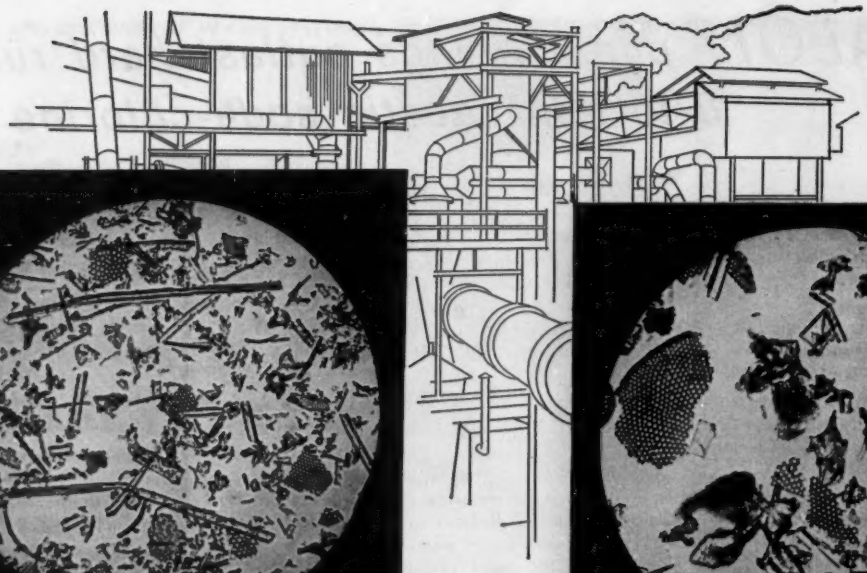
For additional information, write for copies of Protective Linings & Coatings and a free subscription to Elastomers Notebook.



Pump manufactured by Dorr-Oliver, Inc.



Milling and calcining equipment used for all Celite grades.

For high-clarity filtration of most liquids—use this specially milled diatomite, Hyflo Super Cel.

For filtration of larger suspended particles—Celite 545 combines maximum clarity plus faster flow rates.

In diatomites, Johns-Manville precision processing works for you

Constant uniformity in every grade of Celite assures consistent results, less down-time

For mineral filler use—Super Floss grade is made up of carefully sized fines air-floated off in the bag house.

Typical J-M bag house equipment.

As the microscope shows, each grade of Celite* diatomite has its own distinctive particle size distribution. Yet no matter where or when purchased, each remains uniform from bag to bag—your assurance of top production results with minimum down-time.

Three examples of flux-calcined Celites are shown here. Hyflo® Super Cel is widely used for filtration in many industries. It has just the right combination of coarse and fine particles to assure optimum clarity and flow rates. Celite 545, with a higher percentage of coarse particles, is used to achieve maximum clarity and faster flow rates with liquids that have larger suspended particles.

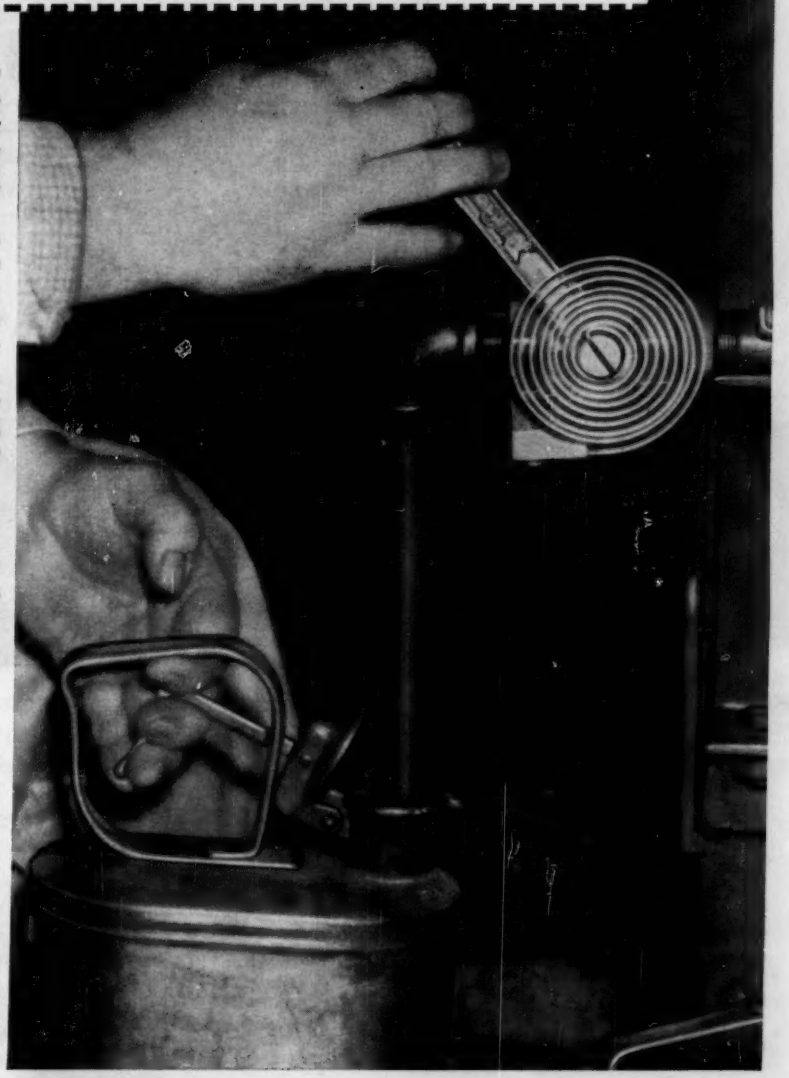
Super Floss, one of several bag house grades, has fine particle size distribution. A white powder, it is processed within very narrow tolerances (less than 1% retained on 325 mesh). It is a popular filler in fine products such as silver polishes.

Johns-Manville can precision-produce so many different grades of Celite because it mines the material from the world's largest and purest commercially available deposit. For assistance with specific filtration or mineral filler problems, talk to a nearby Celite engineer. Or write direct to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products.

JOHNS-MANVILLE

The most dangerous solvents in the world pass through this valve!



But it's a *safe* passage. The ROCKWOOD ¾" (Fig. 802) Self-Closing Ball Valve is designed for *smooth, leakproof* handling of highly flammable liquids. A Rockwood Exclusive!

Take a typical installation at an experimental station of one of the nation's largest chemical companies. Here 36 different solvents, ranging from acetone to xylene, are dispensed from bulk containers. All types of self-closing valves were tried and evaluated for this critical job. None equalled ROCKWOOD for positive performance.

Unique ROCKWOOD Full Round Flow design holds turbulence to an absolute minimum — keeps static at a low level. Flash potential is negligible, greatly reducing fire hazard. In addition, the exclusive "*Spring Pressure* Compensation" keeps ball and seat in snug contact — assures leakproof, dripless shut-off, compensates for wear. Bronze valve body and Teflon trim resist corrosion. After 11 months and 103,200 open-and-shut cycles the company reports: trouble-free operation since installation.

Be as safe and sure with your solvent handling. Send coupon for complete details on the ROCKWOOD Self-Closing Ball Valve. Tested and listed by Underwriters' Laboratories, Inc.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

Distributors in all principal industrial areas

ROCKWOOD SPRINKLER COMPANY
A Division of the Gamewell Company
269 Harlow Street, Worcester 5, Massachusetts

Please send me complete details on the ROCKWOOD ¾" (Fig. 802) Self-Closing Ball Valve.

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Title.....
Company.....
Street.....
City.....*Zone*.....*State*.....

Will success spoil the 53P controller?

Success due to luck may spoil . . . but the 53P has *earned* its recognition over the years with a combination of advantages offered by no other pneumatic controller. Standardized design for top level performance has won the 53P an honored place in the process loop . . . behind the panels, in the instruments, and along the catwalks of the country's most progressive plants.

The only standardized controller

One basic 53P accepts pneumatic or mechanical inputs. You get the same performance whether you mount it in a large case instrument, plug it onto a miniature recorder, or field mount it. The same controller permits everything from proportional to three-mode control . . . and the new "universal" offers 2 to 50% proportional and 2 to 100% differential gap action in the same units!

The only regenerative feedback controller

Only the 53P incorporates the F&P principle of regenerative feedback to give you improved linearity and increased gain. A non-bleed type amplifying relay assures low air consumption (.08 scfm, steady state). No other controller offers all these features or equals the static and dynamic performance characteristics built into the 53P. You'll find any number of reasons for the success of the 53P controller in Catalog 53P-4000. Write for your copy, or call the F&P field engineer nearest you. Fischer & Porter Company, 130 County Line Road, Warminster, Pa. In Canada, Fischer & Porter (Canada) Ltd., 2700 Jane St., Downsview, Ont.

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PLEASE SEND:

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I understand that if I am not fully satisfied I can return product for full refund.

NOTE: Prices quoted F.O.B. Wyandotte, Michigan, and subject to change without notice. Freight equalized with normal producing points. Terms: net 30 days, subject to approved credit. L.C.L. orders referred to nearest Wyandotte distributor for quotation.

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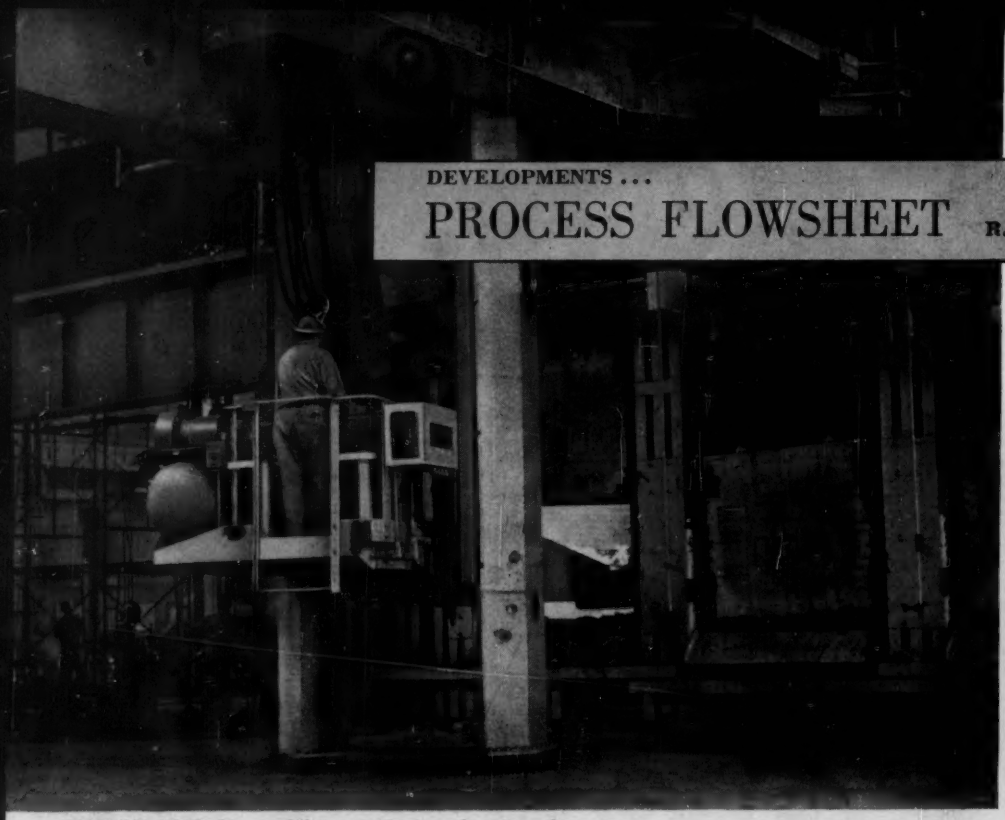
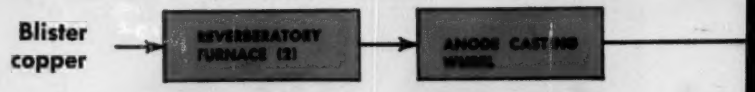
DEVELOPMENTS . . .

PROCESS FLOWSHEET

R. A. LABINE



MOBILE ARM charges blister to the reverberatory furnace.



New Layout Streamlines Copper Refining

By placing heavy design emphasis on efficient materials handling, Kennecott is slicing operating costs at its new $30-million refinery.

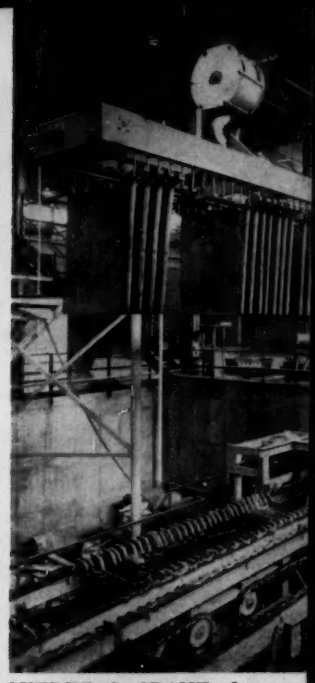
Copper, one of man's oldest and most valuable metals, has been produced by a variety of processes through the ages. Though modern industry has picked the electrolytic process as the most efficient refining route, for proof that this is anything but a "standard" process, take a look at Kennecott Refining Corp.'s new $30-million copper refinery on the outskirts of Baltimore, Md. This new facility is now coming up to its rated capacity of 16,500 tons/mo.

Around the basic electrorefining process Kennecott has assembled an array of modern materials handling equipment to make the new refining operation the most streamlined in the industry. Straddle carriers, conveyors and automatic machinery eliminate many of the traditional hand operations, cut labor requirements drastically. The work force of about 570 when the plant reaches full capacity will represent an investment of over $50,000 per employee. And although plant is still going through shakedown runs, this heavy investment is already showing results in improved productivity and tighter quality control.

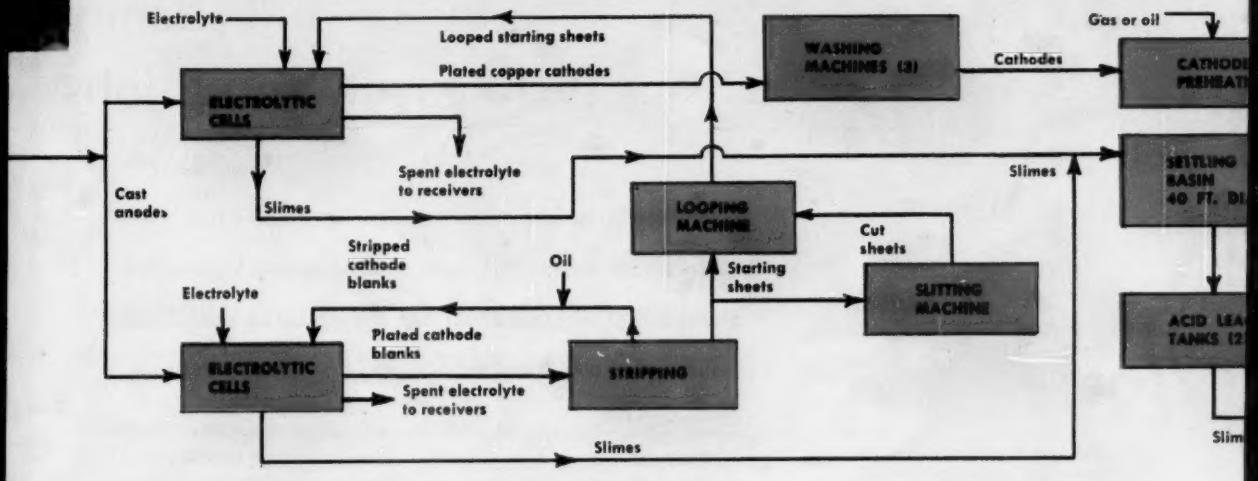
Engineering and plant construction were handled by the M. W. Kellogg Co.

►**Starts at the Dock**—Most of the refinery's raw material, 99.4% fire-refined copper blister, arrives by boat from Kennecott's South American sub-

CASTING WHEEL automatically stacks anodes on a conveyor before pickup.



OVERHEAD CRANE places an



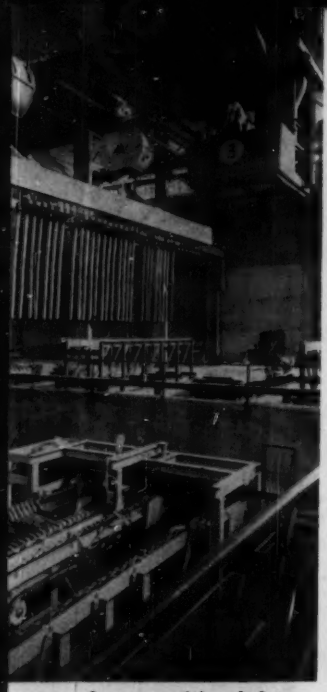
sidiary. After a short rail trip, blister is unloaded by an overhead crane in the storage area.

To charge copper blister to the reverberatory melting furnaces, blister is loaded on bolsters, picked up by straddle carriers and taken to the charging machine which feeds copper into one of the two furnaces. To take some of the "black art" out of furnace operation, Kennecott has started using disposable thermocouples (now used in the steel industry) to determine optimum time for tapping, rather than relying on operators' visual temperature estimates.

►**Improving the Wheel**—Molten copper flows to a novel anode casting wheel which turns out two anodes every 35 sec. Anodes are automatically stacked on a conveyor, then are picked up by an overhead crane in bundles of 48 which can then be transported to the tank house.

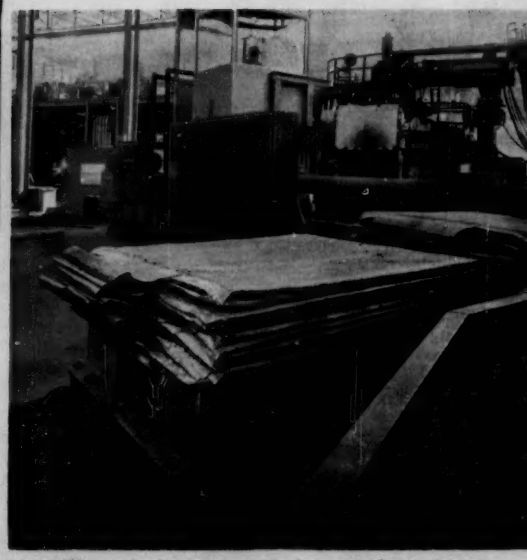
Kennecott has also streamlined the making of copper cathode starting sheets. Pure copper blanks are placed in the electrolytic stripping cells for 24 hr. while a 12-lb. layer of copper builds up. Overhead cranes lift the sheets out of the stripping tanks and place them on a conveyor while the newly formed copper layer is stripped off.

The stripped copper sheets then feed to the looping machine where copper loops are automatically crimped on. When copper bars are inserted

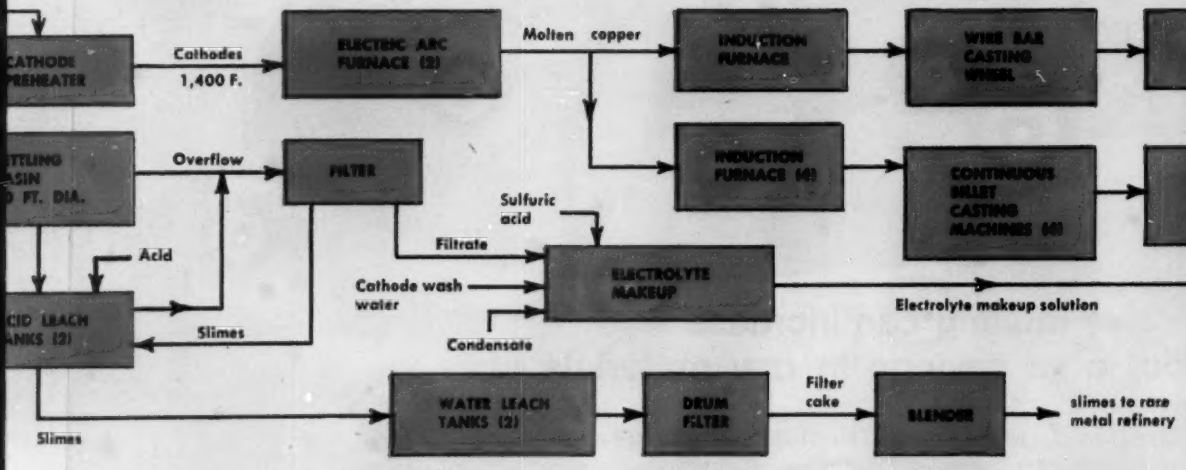


aces anodes on waiting bolsters.

LOOPING MACHINE crimps loops on the copper starting sheets which form the cathodes for electrolysis.



PLATED cathodes are stacked on preheat furnace c



through the loops, this assembly serves as the starting cathode for the electrorefining step.

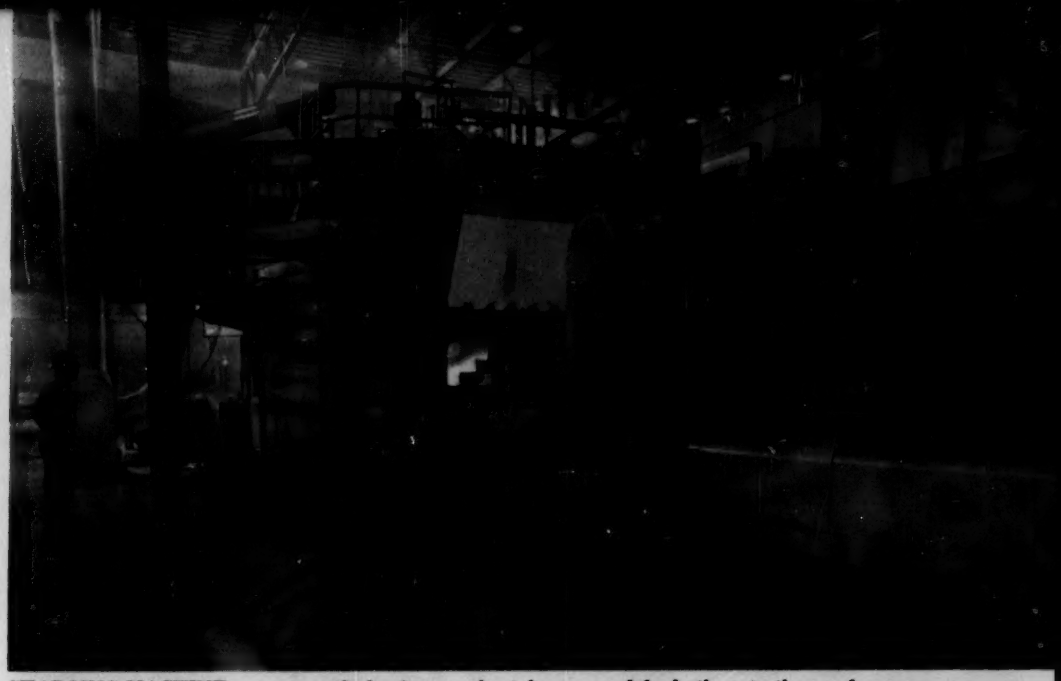
▶**In the Tankhouse**—The new Baltimore refinery contains 1,172 electrolytic cells in the tankhouse. Anodes are electrolyzed for about 28 days. Every 14 days a 300-lb., 99.95% pure copper layer builds up on the cathode; impurities form a sludge on the bottom of the tank. Circulating electrolyte contains about 190 gpl. H_2SO_4 and 50 gpl. Cu. Cells operate with a current density of about 22 a./sq.ft.

When the anodes are almost totally consumed, an overhead crane lifts the refined cathodes out of the tanks and places them on a conveyor which takes them through a novel automatic tunnel washer where traces of electrolyte are flushed off. Cathodes are then stacked on bolsters and straddle trucks transport them to the casting house.

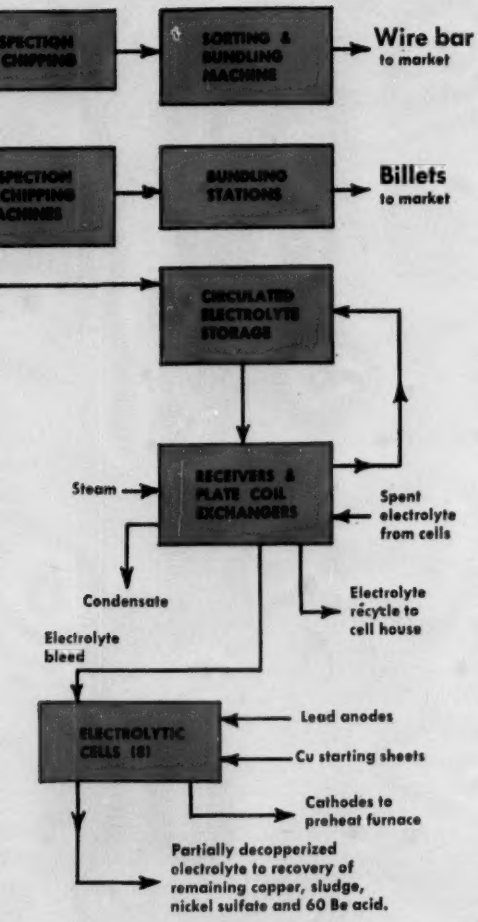
▶**Electric Melting**—In the casting house, refined cathodes are picked up by fork trucks and placed on the feed conveyor of the oil or gas-fired preheat furnace which brings the copper up to 1,200 F.

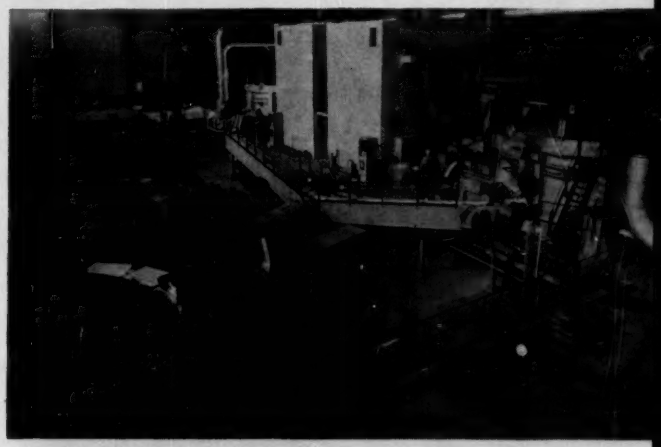
The same machine which charges the cathodes to the preheat furnace then removes heated cathode stacks and feeds them to the 13,500-kva. electric melting furnace which holds 90 tons. Molten metal flows to the wirebar casting wheel which produces four wire bars per mold. These are automatically removed from the casting wheel,

ce conveyor.



CHARGING MACHINE removes cathodes from preheat furnace and feeds them to the arc furnace.





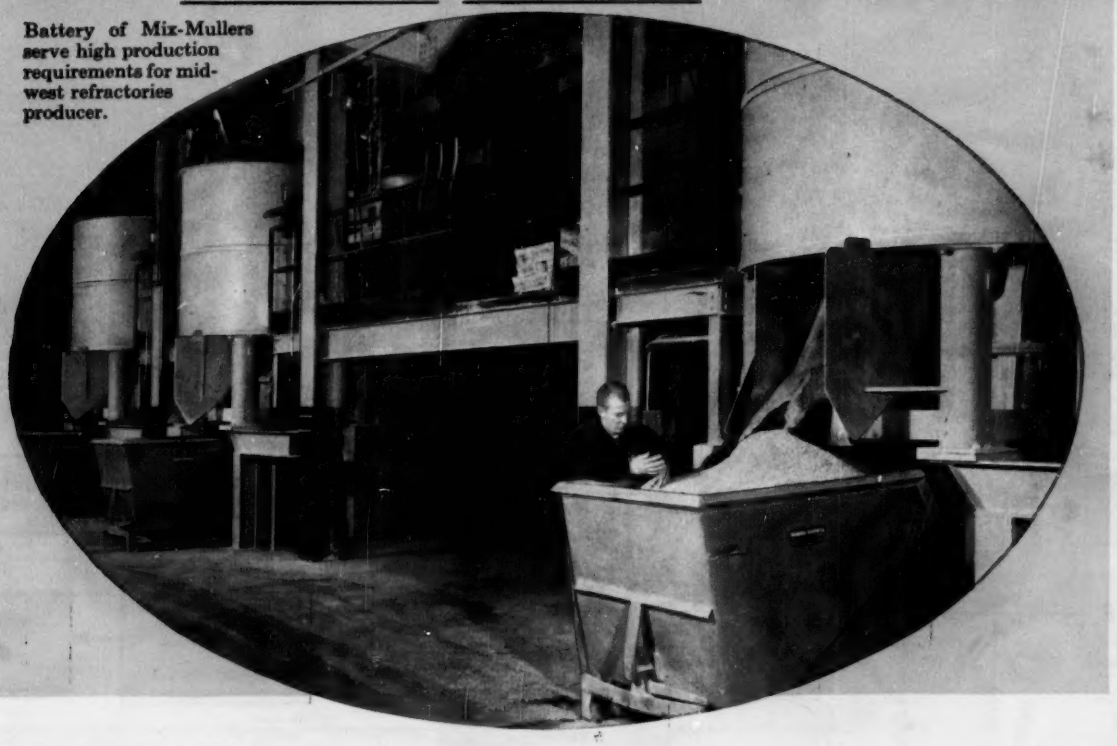
ARC FURNACE, right, dominates the casting floor.

conveyed to a bundling station and are strapped into bundles. Fork-lift trucks run these bundles into railroad cars which pull right up alongside the building.

Kennecott has also installed four unique casting machines which turn out copper billets continuously. Molten copper is lifted in a ladle to the upper casting floor where it flows through special water-cooled molds which form the round billet continuously. A flying saw below each mold cuts the billet into lengths to meet customer requirements. This continuous casting process was developed in conjunction with American Smelting & Refining (see *Chem. Eng.*, May 5, 1958, p. 62).

MIX-MULLER®

MEANS CONTROLLED DISPERSION FOR DRY SOLIDS:



Battery of Mix-Mullers serve high production requirements for mid-west refractories producer.

Intensive mulling can increase output at a savings in raw materials

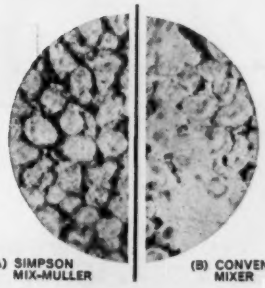
Increase in the usage of the Simpson Mix-Muller has paralleled an enlightened attitude on mixing practice among processors who have learned that careful and *controlled* mixing operations can be an important source of savings in the preparation of dry solids.

In the Simpson Mix-Muller, an intensive kneading, smearing, spatulate action—a mulling action—serves to actually *coat* one material with another. Dispersion of important and expensive components of the mix is rapid, thorough . . . and under your complete control.

If you're caught in the bind between expensive raw materials, increased production demands and boosted quality control standards . . . can you afford to settle for *less* than *controlled dispersion?* Write for details on a confidential **mulling** survey.

See our advertisement in CHEMICAL ENGINEERING CATALOG

Here's why:



(A) SIMPSON MIX-MULLER (B) CONVENTIONAL MIXER

Unmixed smears evident in (B) can cause waste of raw materials, "hot spots," rejects and reprocessing. These unmixed areas make quality control difficult and can nullify any mixer manufacturer's claim for fast mixing.

SIMPSON MIX-MULLER® DIVISION

National Engineering Company

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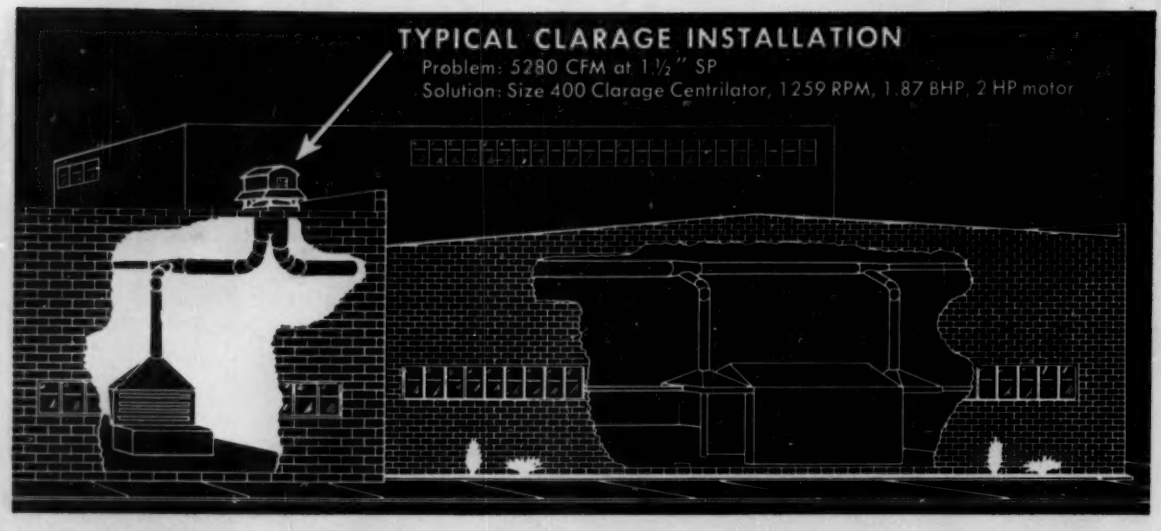
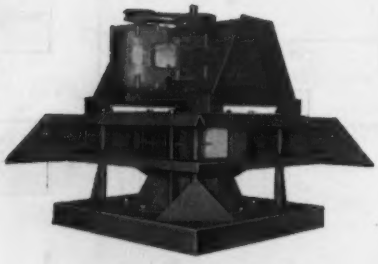
WRITE FOR HANDBOOK

Handbook on Mulling describes controlled dispersion in simple terms, provides full details on nine models of the Simpson Mix-Muller; how it is used; how it can benefit you.



Demonstrating...

how to save space and money on your next air handling jobs



V-belt driven centrifugal type with backwardly inclined blade wheel. 10 sizes. Capacities from 1,500 to 26,500 CFM. (Shown above with weather enclosure and two sides of air apron removed.)

YOURS...ALL YOURS...with the Clarage Centrilator®* power roof ventilator. Handles static resistances to 2". Requires no floor space. Minimum installation cost. Unequalled accessibility. High efficiency for low operating cost. Ideal solution for numerous industrial systems such as the one shown above.

Get full information on the Clarage Centrilator and its exclusive Jet Siphon™ Air Flow Director feature. Request Bulletin 550 or contact the nearest of our 58 sales engineering offices today. CLARAGE FAN COMPANY.

* Patent applied for

Dependable equipment for making air your servant

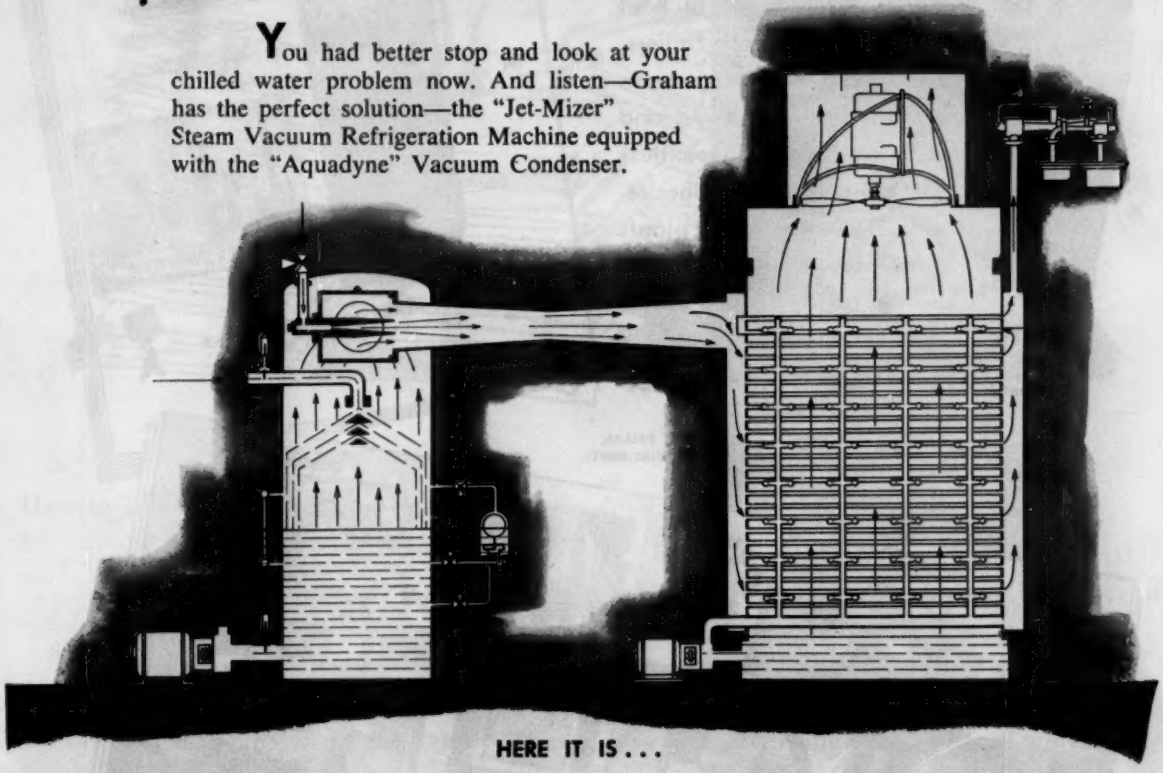
CLARAGE

Kalamazoo, Michigan

STOP... LOOK... ...and LISTEN!

Are you being held up for lack of cold water?

You had better stop and look at your chilled water problem now. And listen—Graham has the perfect solution—the "Jet-Mizer" Steam Vacuum Refrigeration Machine equipped with the "Aquadyne" Vacuum Condenser.



HERE IT IS...

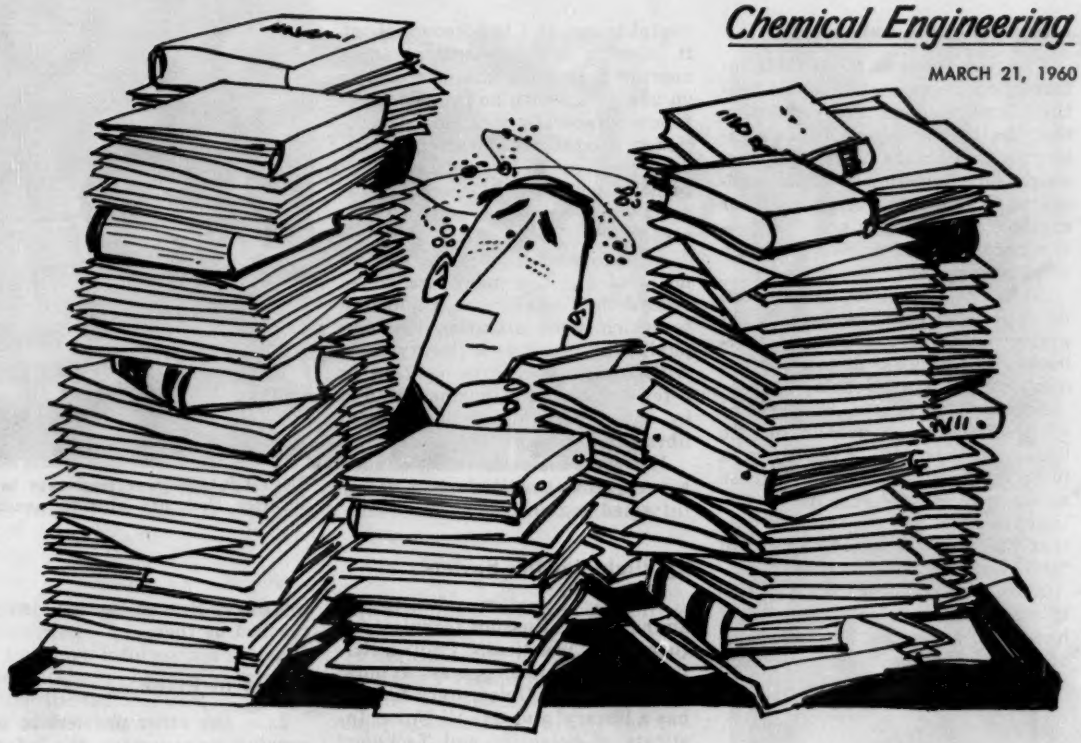
...and here are a few of the things the "Jet-Mizer-Aquadyne" combination will do for you.

1. Provide any quantity of chilled water for your process requirements.
2. The Aquadyne Condenser requires no external source of cooling water whatsoever (provides its small amount of make-up water from its condensate).
3. A minimum of moving parts, hence a minimum of maintenance—completely automatic.
4. Extremely economical to operate and low in initial cost.

GRAHAM MANUFACTURING CO., INC.
Heliflow Corporation
170 GREAT NECK ROAD • GREAT NECK, NEW YORK
Offices in principal cities and Canada

Factory: Batavia, N. Y. Other Graham precision-built products: Steam Jet Ejectors, HeliFlow Heat Exchangers, Monobolt Heat Exchangers, Deaerating Heaters, Surface and Barometric Condensers.

Chemical Engineering
MARCH 21, 1960



How to solve an engineering challenge of the 60's . . .

The Information Problem

Will an overabundance of information eventually smother your ability to use it profitably? Here's how to get through the wall of words.

LAURENCE W. ROSS, Georgia Institute of Technology, Atlanta.

What causes most wasted engineering time? When four engineering executives were asked this question in a recent survey,[1] three of them cited the information problem: the difficulty of getting facts to the engineers who have to use them.

Management is beginning to realize that knowledge is indeed power, that the price of ignorance is "technological surprise."[2]

Once upon a time it was safe to rely upon textbooks, handbooks and just a handful of magazines for all engineering information. Now it is too risky. Soon it will be fatal—professionally speaking—for an engineer to be this ignorant.

There is simply too much high-quality material being published today. New magazines are appearing (they double every 20 years); existing publications are expanding their coverage and services (witness *Chemical Engineering's* change to biweekly frequency at the start of 1958); abstract journals and index services are swamped with the loads they are expected to carry. Each year they have to work harder and harder and run faster and faster just to keep pace.

Standard reference works have been hardest hit by the information problem. Just to give one example, it is said that the *International Critical Tables* may never be revised and brought up to date. For if they were, their size would increase a hundred fold! And no business publisher could afford to undertake the revision.

Library Equals Laboratory

The pure sciences faced their information crises earlier in the century, and reached the conclusion that the library equals the laboratory in importance. Now every research organization has a well-equipped library. No chemist, for example, would begin an investigation before he had made a thorough literature search.

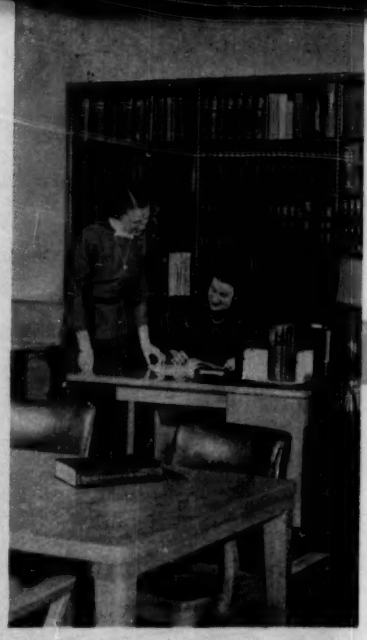
Not so the engineer. It has been my experience that the chemical engineer first surveys his old textbooks, then he looks at some of the company reports. Nothing more!

He can't do more, even if he wishes because he usually has no library to turn to. Even when a library is available to him, he has no encouragement to use it. His college training has taught him only that there exists something called "the literature."

Since I left engineering practice to make information my career, I have been astounded by the wealth of material which could have been useful to me, if I had known about it. Design and development engineering frequently meant working on new ideas, with no precedents to follow. Naturally this led to inefficiency, false starts and often a dubious product. I remember that principles carried us through, but facts would have been so much better!

An informed engineering staff is no accident. Too many executives regard the literature as a nuisance to which some attention must be paid. The result is a library filled with company reports, containing a few books and magazines, staffed by one underpaid sub-professional librarian.

However, the usual result of such a management attitude is a poorly informed engineering staff.



ENCOURAGE your engineers to use libraries that are already available.

Spotlight on the Soviets

Recently I had occasion to examine Soviet Russian technical information practices. Ivan's attitudes offer a vivid contrast to ours.

In the Soviet Union every factory has a library[3] and the All-Union Institute of Scientific and Technical Information uses a staff of over 15,000 people to churn out information. New techniques are exchanged freely among plants throughout the Soviet Union. Foreign publications are distributed rapidly and read avidly, so that the Russians know more about our technology than we do.[4]

Plainly the Russians have given special attention to technical communications. They do not intend to repeat our mistakes. By making efficient use of our technical literature, they can begin where we leave off.

Today they have a flourishing chemical engineering literature of their own. For example, you can leaf through a current Russian technical magazine and find such titles as, "The Effect of the Processes of Heat and Mass Transfer on the Reaction Velocity of the Ethylene Oxidation" and "Tubular Reactor for the Continuous Polymerization in Emulsion." These two articles both appeared in *Khimischeskaya Promyshlennost* (Chemical Industry) for March, 1958. Unfortunately, this journal is not translated into English.

Both these articles would have interested me profoundly a year and a half ago, during my engineering days. But no Russian journals reached us then.

Yields to Planning

Like any other problem in engineering management, the information problem yields to planning. Even the smallest organizations can, by proper planning, keep their engineering staffs well-informed.

Every program has two major objectives. They are:

- To enable engineers to learn of and to obtain copies of practically any information in print.
- To bring to engineers' attention current developments in their fields of specialization.

Secondary objectives may include: correlation of information flow among various technical groups within the company; centralized control of company technical reports; stimulation of patent and publication activity. In the discussion that follows, we will consider only the major objectives in detail, since the other possible objectives all require interpretation in terms of particular company policy.

The heart of the information plan is a library. This does not mean that every engineering organization must have a library. But *somewhere* in the plan there must be a source of literature. There are at least four alternatives for such a source:

1. An engineering library.
2. A nearby library serving research or development operations.

ONLY 11% OF ENGINEERS prefer to do their literature work in the library itself. Easy access to open shelves adds to the value of your library.

3. Public libraries in your nearby communities.

4. Contract information service.

Each alternative has its strengths and its limitations. So, let's examine each briefly.

Your Own Library

Your own engineering library is the best—and the most expensive—source of engineering information. Moreover, it is the only means which guarantees full participation by the engineers in the company's information program.

An engineering library is more than a repository for books, reports and magazines. To be of real use the library must be designed and equipped with forethought. Fortunately, professional help is available in this area. The Special Libraries Assn. provides a consultation service for those who need such help. Details are given in the box on p. 144.

First need of the engineering library is a professional librarian. Ideally—and if you can afford it—the librarian should be an engineer with library training. Without such a person, who understands the scope of chemical engineering literature and who possesses insight into the tangled jungle of Libraryland, the engineering library is severely hobbled. With such a person, the engineers who use the library may be sure that their needs will be served, and management may be sure that the information plan will proceed with a minimum of executive direction.

Physical setup of the engineering library should include: an up-to-date bookshelf, a collection of major abstracting journals and indexing services and subscriptions to about 100 periodicals. Another useful item is a data file of physical properties for the company's products and their raw materials. Often, a collection of chemical equipment catalogs is of great help.

Large companies often provide extensive library services: editing reports, performing literature searches, publishing reviews of current literature and performing other "objectives" as mentioned above.

Knox, *et al.*[5] have recently discussed the economics of large-scale information services. In research organizations, the technical information budget is as much as 2.5% of the total research budget, or up to $500/yr. for each member of the using organization.

This may be considered to be the upper limit of information expense. In general, engineering projects will not, as research projects sometimes do, consist of one-third literature work and only two-thirds original work.[6]

The mechanics of establishing a library have been discussed in several articles.[7, 8, 9] Apparently library space requirements need not be large; only 11% of technical personnel prefer to do their literature work in the library itself.[10]

SPACE REQUIREMENTS are not large; can be surprisingly small.

Using Existing Libraries

If the research or development department maintains a well-equipped library nearby, the company's engineers can be encouraged to use it.

Normally this type of library is not entirely adequate for engineering use. Consequently, the engineers may wish to use part of their information budget for expansion of the research/development library holdings, services, or both.

Using Your Public Library

Except for large metropolitan areas, or for special cases where local industry requires it, the public library offers the use of a meager technical collection. Even so, your local public library may still be very useful in your engineering information plan.

In the first place many public libraries do subscribe to *Chemical*

Abstracts, Engineering Index and to the *Industrial Arts Index* (which was divided on Jan. 1, 1958 into two parts: *Business Periodicals Index* and *Applied Science & Technology Index*). These abstract and indexing journals are particularly useful to chemical engineers.

The main advantage of the public library, however, is its facility for acquisition by inter-library loan: "Few technical men realize what public libraries can obtain, even small neighborhood ones."[11] They can borrow almost anything in print, and obtain photocopies of the rest. Obscure material is no handicap; on the contrary, it is meat and drink to the professional librarian. And if it can be found in the Western world, the engineer can get it.

Note, however, that there is one usual restriction on the inter-library loan service. Material obtained in this way is supposed to be used only in the library itself.

With the aid of abstracting and indexing services to find material and the local public library to acquire it, even the smallest organization can maintain a limited but effective information plan.

Information by Contract

Few chemical and engineering companies can afford the library they really need. Only the largest can match the collection of books and periodicals found in the libraries of the major technical schools, for example.

Since this is the case, it's surprising that the chemical industry has been so reluctant to "farm out" its information needs to organizations which have access to first-class literature resources.

There are a number of organizations which actively solicit contracts for information services. We've listed some of the major organizations of this type in the table on p. 147. The list includes: consulting firms; universities, or their affiliated research stations; and independent libraries.

In addition to the organizations listed in our table, many others are available for providing contract information services. In fact, there is no reason that we know of to prevent any research or consulting organization from accepting an information project as readily as any other, if literature resources are available.

For example, if your employer decides to enter a new field involving, let us say, aliphatic amines, there may be a need for a literature search through the entire technology of amine production. This is a large order for a company library. However, any one of several organizations would be glad to perform it on contract. Any of them can muster the necessary specialists; the universities are particularly deep in available talent.

Literature reviews, discussed below, can also be supplied readily—and inexpensively—by contract information services. A well-stocked library receives perhaps 5,000 periodicals; the engineering organization, by contracting for review service in certain fields, could receive the benefit of practically all these periodicals.

Getting the Facts

When a project is born, engineers begin marshalling all available facts about the process. To their immediate knowledge the group adds what data the company has on file, then turns to the literature.

After all, "If the decision based on your data is going to involve $1,000,000, you want to be sure it's the best data you can lay your hands on."[12]

Fortunately, the chemical industry has at its service the finest abstract journal in the world: *Chemical Abstracts*. Abstract journals are examples of "secondary sources" which make reference to the "primary sources" consisting of books, articles, patents, etc. Other secondary sources include bibliographies, catalogs and indexes.

A literature search involves examining all the secondary sources which are pertinent (and available). Chemical engineers nearly always include *Chemical Abstracts* in their searches, but they often overlook other sources which could be useful. *Chemical Abstracts* is not absolutely comprehensive. Furthermore, its indexing is now two years behind.

Some of the complexities of literature searching will be illustrated by the following example. The author once had occasion to design the reaction section of a new plant which was to produce an organic liquid. One reactant was a gas, the other a liquid.

Process requirements dictated a large excess of gas and a high degree of mixing. The solution seemed to be a tubular or draft-tube tank reactor (with recirculated liquid). Problem: What is known about gas-liquid contacting in tubular apparatus?

In this case *Chemical Abstracts* was of limited help. Two or three useful Japanese references were uncovered, but nothing else of direct interest. By sheer coincidence one year later, after leaving the chemical industry, I conducted an extensive literature search on the general topic of two-phase (gas-liquid) flow, during which I uncovered several prime references on mass transfer in gas-liquid flow systems.

Nuclear Science Abstracts and *Dissertation Abstracts* revealed useful material of a type not indexed elsewhere. Examination of Russian articles led to more articles in the Russian literature; the single most pertinent article was found in this way.

The findings in this second search revealed the shortcomings of the first. I am now convinced that multiple secondary sources should always be used unless the topic is strictly chemical. Another conclusion: Abstract journals are not enough.

Most Often Overlooked

Abstract journals, in general, overlook four important kinds of material: government publications, theses (especially master's theses), papers delivered at conferences and trade literature.

To fill this gap, government publications may be monitored through *United States Government Research Reports*.[13] For an extensive discussion of availability of government research reports, we recommend Ref. 15. Ph. D. theses of many schools are covered in *Dissertation Abstracts*, but the schools themselves are the only sources of information on master's thesis material. Conference papers are monitored best through professional journals and business publications. Trade literature is difficult to keep watch on, although *Chemical Engineering Catalog* and the *Buyers' Guide Issue, Chemical Week* are of some assistance.

Small-scale engineering projects require, if anything, more initial information since less money will be

available for research and development. Crash programs likewise demand thorough data compilations because of time limitations and the possibility that design must be based upon published data alone.

The published literature includes magazines, books, monographs (e. g., reports of the Atomic Energy Comm., proceedings of conferences), patents and assorted secondary sources. The nature of technical literature has been well reviewed by Jackson.[16]

Since we are concerned here chiefly with obtaining and using the literature, only secondary sources and, to some extent, technical magazines will be examined.

Your Technical Magazines

Every engineering organization recognizes that professional journals and business publications are the major sources of new engineering information. Consequently, engineers usually have the opportunity to examine well-known magazines when these are circulated among the staff.

How many magazines should be circulated? At least 40 publications may be considered to be important to chemical engineers. And the engineer to be truly well-informed should examine about 100 magazines each month.

What's more, new scientific periodicals are born every week or two.[17] This poses a dilemma, since the growth of technical literature requires more and more reading time encroaching more and more on engineering time.

One company, observing with alarm the number of publications on its routing lists, offered to subsidize individual subscriptions if the engineers would promise to read the magazines at home, instead of at work. Other companies frankly discourage more than minimal reading of magazines.

These are makeshift and (in the long run) expensive solutions to the problem. Useful information is being published at an ever-increasing rate. Some observers feel that technical periodicals, because of their proliferation, are no longer feasible information media.

We have all heard comments such as, "I have learned to live with the fact that people can publish papers faster than I can read the titles." Accordingly, there is mounting sentiment toward secondary sources as the main currency of scientific information.[18]

Reviewing the Literature

The most popular secondary source, and the most efficient solution to the technical-journal problem, is the literature review. It consists of selective coverage—either titles or titles plus abstracts—of current literature.

Many organizations publish reviews; some, like the *Battelle Technical Review*, have achieved national circulation. All have as their purpose the monitoring of current literature in particular fields, to serve the organization's technical staff.

Here's why a literature review can be advantageous:

- A wide range of literature (not just magazines) may be covered.
- Engineers are apprised only of pertinent information, and time ordinarily spent with "interesting" but nonuseful information is saved.
- Routing-list delays are eliminated.
- A single review service may well serve a very large or diverse organization.

The editors of monitoring publications, knowing the needs of the various groups and individuals that use the service, will include not only current magazines but also patents, book announcements, thesis literature, government publications and other sources as required.

Certain publications like *Chemical Engineering* which are especially pertinent and which contain news of the industry, professional news and advertisements of interest will still require cover-to-cover examination. [EDITOR'S NOTE—*Whew! That's a relief.*] In fact, subscriptions should be encouraged. The bulk of the literature, however, is not in this category and need not clutter engineers' desks. [EDITOR'S NOTE—*The above opinion is that of the author and does not necessarily represent that of Chemical Engineering magazine or of the McGraw-Hill Publishing Co.*]

Reviews of the literature can serve the plant as well as the labs and offices. Plant engineers, nurtured in the "tool school" of self-reliant engineering, often need to be reminded of what the literature holds for them. A concise literature review service can perform this function in management's information plan.

Simplest form of literature review is the table-of-contents reporter. A growing number of organizations use this method. Each month tables of contents from numerous journals are reproduced by some "instant" copying method, and the copies routed to groups or

Information Services

Organization and Address

Armour Research Foundation
Technology Center
Illinois Institute of Technology
Chicago 18, Ill.

Battelle Memorial Institute
Information Management Div.
505 King Ave.
Columbus 1, Ohio

Chemists' Club Library
51 East 41st St.
New York 17, N. Y.

John Crerar Library
86 East Randolph St.
Chicago 1, Ill.

Engineering Societies Library
29 West 39th St.
New York 18, N. Y.

University of Florida
Engineering and Industrial
Experiment Station
Gainesville, Fla.

Georgia Institute of Technology
Technical Information Section
Engineering Experiment Station
Atlanta 13, Ga.

Arthur D. Little, Inc.
30 Memorial Drive
Cambridge 42, Mass.

Lowell Technological Institute
Research Foundation
Lowell, Mass.

University of North Carolina
Industrial Experimental Program
Chapel Hill, N. C.

University of Pennsylvania
Industrial Report Center
Institute for Cooperative Research
Philadelphia 4, Pa.

Pennsylvania State University
Industrial Reference Div.
College of Engineering and
Architecture
University Park, Pa.

Stanford Research Institute
Menlo Park, Calif.

individuals who then request copies of any articles they desired.[20, 22]

There are now several commercial ventures of this sort; for topics in pure chemistry the best is *Current Chemical Papers*, published monthly by the Chemical Society (London), reporting titles from 521 journals. Another is *Current Contents* published by Eugene Garfield Associates, New York. The latter covers major chemical engineering periodicals (among others) and costs $100/yr.

Reprints and Translations

Every information plan includes provision for obtaining reprints and translations, which the engineer must have if he is to use the information.

Copies of magazine articles may be obtained from the publishers who may offer them for sale as reprints. In some cases the author of an article may be willing to supply a free reprint of his article. If your own company library does not have a copy of the article you want, it can be ordered from the New York Public Library, the Library of Congress, or any of several others. Photostats cost from 35¢ to 50¢ per page.

Microfilm or microfilm cards cost less, and may be preferable if a large literature collection is being organized, but they require auxiliary equipment for their use. Some organizations obtain copies by contract with technical information services, who perform the mechanics of acquisition.

LAURENCE WILLIAM ROSS is a Georgia Tech chemical engineer (B. S., 1954; M. S., 1956) who began his professional career as a process design engineer. Then he decided to devote his attention to the information crisis. He has returned to the engineering experiment station of Georgia Tech in Atlanta, where he specializes in technical information.

Translations will normally be required as the result of literature searches. Although engineers normally obtain about 90% of their information from domestic sources,[19] foreign publications—particularly the hard-to-get items—have a way of being especially desirable. (Note also, that domestic sources account for only 25% of the world's chemical literature today.)

For example, when your author performed the above-mentioned literature search on two-phase flow reactors, he came up with the following reference:

Yagi, Sakae and Yasuo Kato, "Vertical Tube Reactor I. Flow Pattern and Holdup in Gas-Liquid Two-Phase Flow" *Chemical Engineering (Japan)*, 15, pp. 317-322 (1954).

This seemed to be a valuable reference. A translation seemed appropriate. Unfortunately, management did not share your author's regard for foreign technical literature.

In drawing up an information plan, management should recognize the importance of foreign literature, and encourage engineers to obtain more translations. Patriotism has no place in the technical library. As Burton[21] has recently pointed out, Americans are famous for ignoring foreign literature; the few foreign citations used by American authors are likely to be of the "cornerstone" variety, chosen from the writings of an old master, and often half a century old.

The American attitude has been expressed facetiously; "Remember, the best ideas originate in the U. S. Other people have to think and talk in a foreign language. This gives you a tremendous technical edge."[22]

When translators are not handy (the usual case), the engineer can often locate one through classified advertisements in magazines or telephone directories. A directory, "Translators and Translations: Services and Sources"[23] is now available from the Special Libraries Assn., and it is recommended for those who anticipate needing translations from time to time.

Translations are expensive: $1.50-$2.00 per 100 words, on the average. Money can be saved if the engineer can consult the translator personally. The two of them can separate what is valuable from what is not worth translating.

What Will It Save Me?

The reader is apt to ask, "How much money can an information plan save my staff?" Of course no data exist on this subject.

Personally, I have heard one company's estimate that it saves 10% on engineering outlay by having a technical information program. However, the real gains are likely to come from infusion of new ideas into research and design work.

Technological surprise awaits those who choose to remain ignorant of the printed past. It is only a question of time until history repeats, and some chemical engineering organization duplicates the classic blunder of an electronics firm, reported two years ago.

This group spent $200,000 and five years on a network synthesis program, only to find that the entire problem had been solved and published by—guess whom—the Russians.

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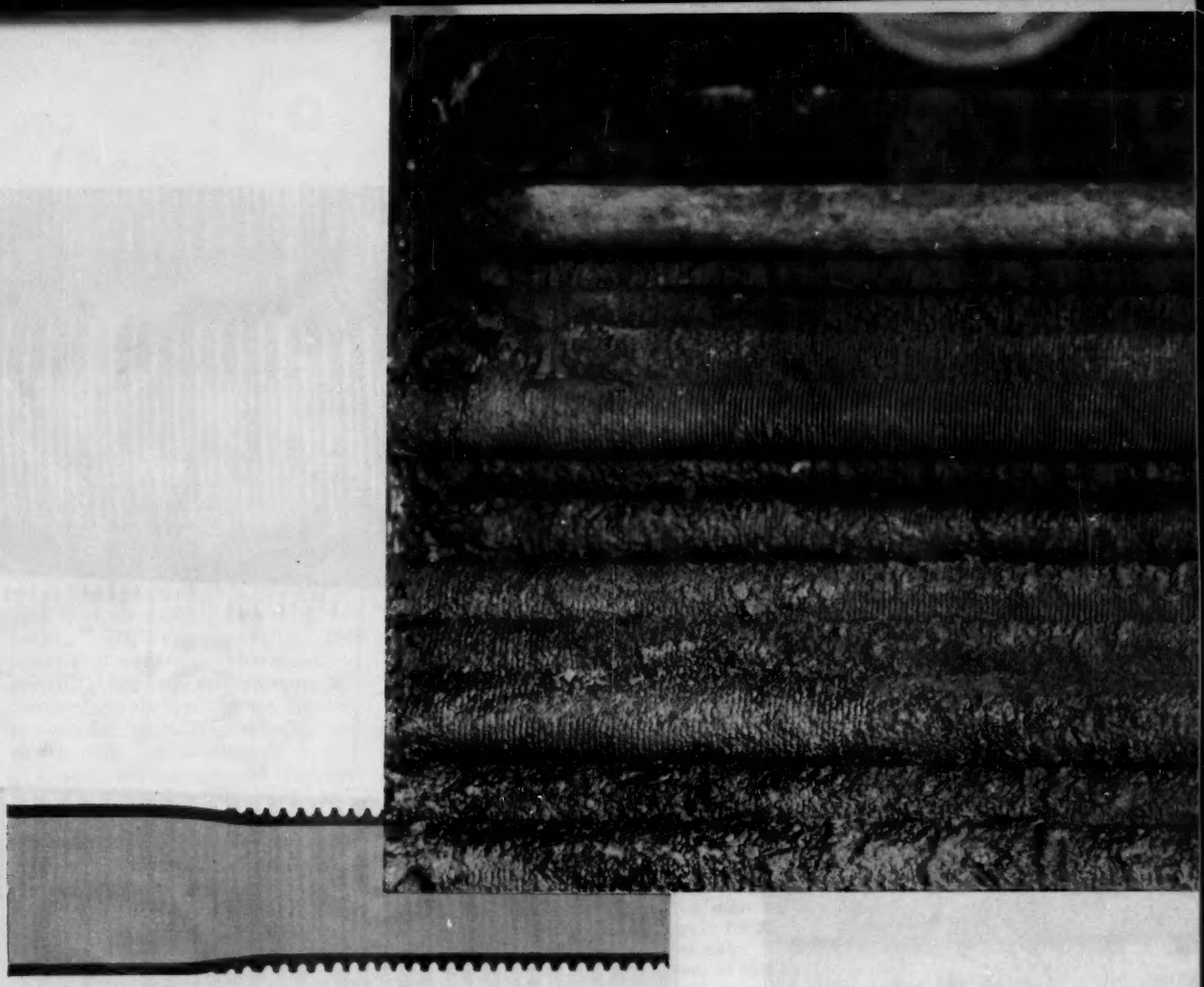


Under Fouling Conditions — Finned Tubes Can Save Money

Experience shows finned tubes foul less, clean easily, give higher heat transfer rates than conventional tubes.

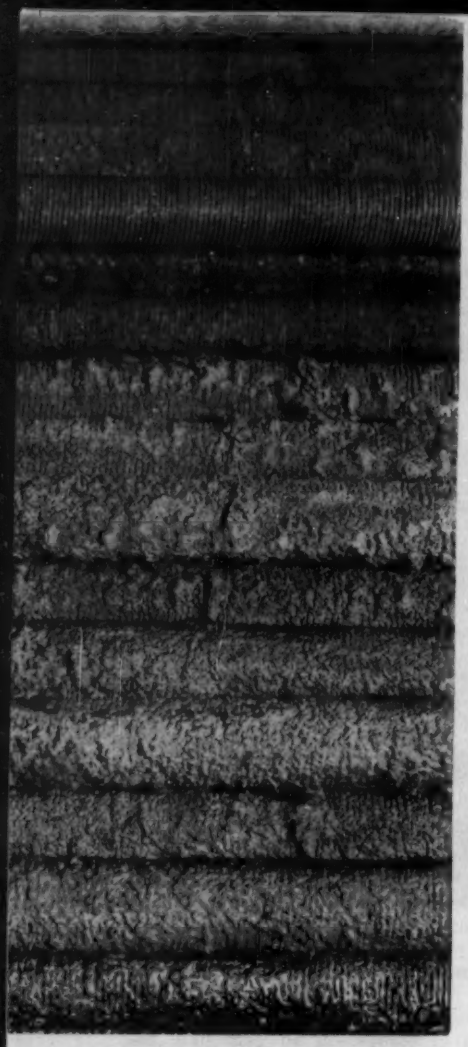
W. O. WEBBER, Staff Engineer, Humble Oil & Refining Co., Baytown, Tex.

FINNED tubes in dirty service? Preposterous! They would foul so fast, your heat transfer would drop off to nothing in no time and they would be almost impossible to clean.

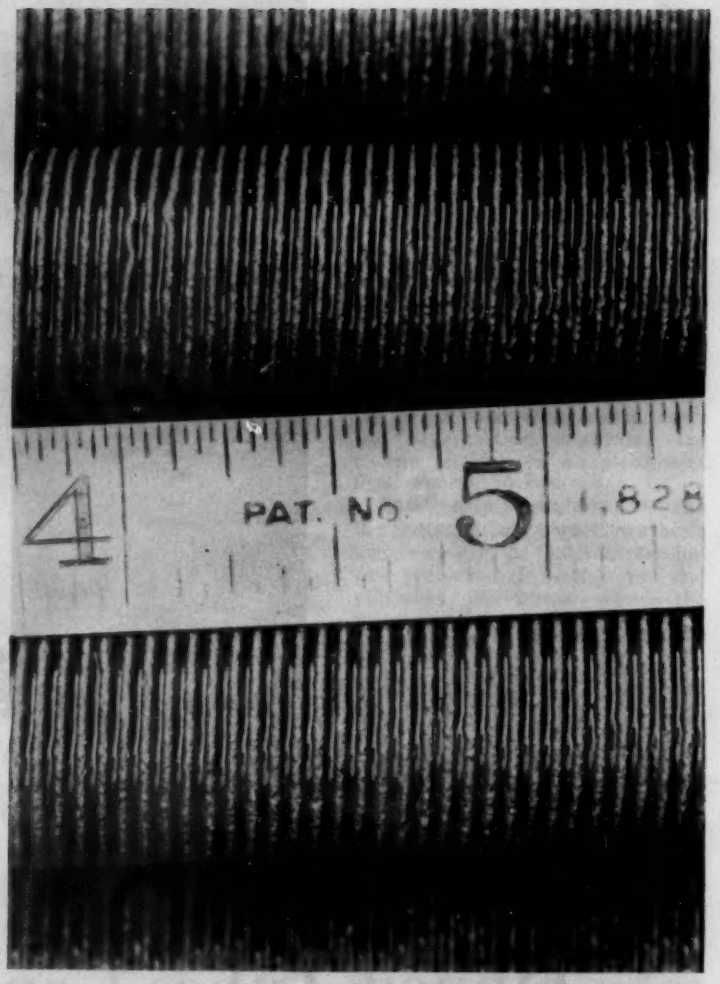
So you might think, but our three years' experience with low-fin tubes in reboilers on the Light Ends Fractionation Unit (LEFU) at our Baytown refinery indicates otherwise. You can have substantial savings in equipment costs, or significant increases in heat transfer capacity, through the use of fin tubes instead of conventional tubes in heat exchanger bundles for reboilers.

The chemical engineer's business is the ultimate production of "bucks." Therefore, nothing should be done unless economic considerations justify it. The question of fin tubes vs. conventional plain tubes is primarily one of economics—will the fin tubes do the same job for less money over-all.

In this situation, we can consider two cases: (1) bottleneck removal projects and (2) new projects. In the first case, considering reboilers for instance, retubing with finned tubes to provide additional capacity on an existing fractionating column can easily save one-half to one-fifth the cost of plain tubes in a new shell. For new installations, the sav-



Fouled Tubes at inlet end of reboiler.



Sand Blasted Tubes cleaned adequately (below) but minor damage (above) shows need for care in cleaning.

ing is less, the ratio being from $\frac{1}{10}$ to $\frac{1}{2}$. We base these conclusions on the calculated comparisons between finned tubes and plain tubes shown on this page. These calculations, which are based on the assumption that all scale occurs on the outside of the tube, show that the heat input capacity per degree of temperature difference, $U \times A$, is 80% higher for finned tubes.

We first became interested in finned tubes for reboilers when we wanted to expand the capacity of our LEFU equipment. In a new service, one column did not have enough reboiler capacity—and another had too much. We thought at first that we could just switch reboilers but, unfortunately, the tower that needed the increased capacity did not have enough room for the larger reboiler. So we decided to consider increasing reboiler capacity with finned tubes.

That finned tubes would increase heat transfer capacity was well known. Indeed, we had used finned tubes in other applications, but none of these situations involved operating conditions where heavy fouling would be encountered. There was a serious question regarding the usefulness of a finned tube under fouling conditions. The feeling was that the added heat transfer capability added by the finned tubes would soon be nullified by deposits which, in addition, would be far more difficult to clean from finned tubes than plain tubes.

Sample Calculation Shows Superiority of Finned Tubes

We can make a simple, straightforward comparison of plain and finned tubes for a reboiler by calculating the $U \times A$ for one foot of tube length. If we assume a given quality steam, a given fractionating tower pressure and a given bottoms product quality or vapor pressure, the LMTD (log mean temperature difference) is fixed and $U \times A$ measures the heat input capacity directly. We show this comparison in the following table.

Basis

Evaporating hydrocarbon coefficient		300 Btu./(hr.) (sq. ft.) (°F.)
Condensing steam		1,500 Btu./(hr.) (sq. ft.) (°F.)
Size of tube		3/4 in. O. D.
Length of tube		1 ft.
Gage of tube		16 B.W.G.
Ratio outside to inside surface:	plain	1.21
	finned	3.84
Surface per foot:	plain	0.1963 sq. ft./ft.
	finned	0.4960 sq. ft./ft.
Define: $U = \Sigma 1/h$		

Comparison of Resistances

Type Tubes	Plain			Finned		
	r_i	A_o/A_i	$r_o = r_i A_o/A_i$	r_i	A_o/A_i	$r_o = r_i A_o/A_i$
Steam	0.0007	1.21	0.0008	0.0007	3.84	0.0027
Metal	0.0002	1.10	0.0002	0.0007	1.90	0.0004
Dirt	0.0010	1.00	0.0010	0.0010	1.00	0.0010
Hydrocarbon	0.0033	1.00	0.0033	0.0033	1.00	0.0033
Total = total r's, outside			0.0053			0.0074
$U = 1/R$			189			135
A per ft., sq. ft.			0.1963			0.4960
U_o per ft.			37			67
Ratio fin/plain $U_o = Q/\Delta T$				181		

This calculation, based on more or less typical and reasonably clean conditions, shows an 80% gain for fin over plain tubes. This is the extra heat input to be gained per cubic foot of reboiler volume (fixed shell). Gain per dollar of investment is obtained, excluding shell cost considerations, by dividing the U_o's by their respective costs for plain and finned tubes.

Problem Needed Investigation

Since fouling and cleaning problems seemed paramount, we decided to carry out some limited laboratory investigations on the fouling characteristics and cleanability of a single finned tube. Our results strongly indicated that, at worst, finned tubes were no more difficult to clean than plain tubes. Indeed, there was some indication that finned tubes would not foul as readily as plain tubes and that once dirty, they might be easier to clean.

We then made a field investigation at an installation where a finned tube condenser was operating in dirty service. This unit condensed reflux and product taken overhead from a rerun tower, the product being a cracked, sour, H_2S containing 380 F. end point stock.

This condenser formerly contained plain tubes on triangular pitch. Rapid fouling and frequent cleaning made the plain tube bundle inadequate so it was decided to provide greater capacity by changing to finned tubes mounted in the same tube sheets. At the time of the field investigation, the retubed unit had been operating for nearly four years at a load equal to or slightly greater than it was before the switch to finned tubes.

Comparison of the operating history of the plain tubes and finned tubes, shown in Table I, together with our own work on finned tubes, convinced us that we should go ahead with replacement of plain tubes by finned tubes.

Cleaning Comparison

One of the first reboilers retubed with finned tubes was in deisopentanizing service, charging sweetened plant pentanes. This feed stock fouled the reboiler tube bundle severely in a very short time—about six months. A return bend, square pitch finned tube bundle replaced a triangular pitch plain tube bundle.

After about six months of serv-

Nomenclature

A	Area, sq. ft.
a	Subscript for area.
h	Individual heat transfer coefficients, Btu./(hr.) (sq. ft.) (°F.).
i	Subscript for inside of tube.
o	Subscript for outside of tube.
Q	Total heat, Btu.
R	Sum of r's.
r	Resistance to heat flow, (hr.) (sq. ft.) (°F.)/Btu.
T	Temperature, °F.
U	Over-all heat transfer coefficient, Btu./(hr.) (sq. ft.) (°F.).

Performance of Finned and Conventional Tubes in LEFU Reboilers Compared—Table I

Tube Type	Service	Q	ΔT	A_o	U_o	Total Tube Length, Ft.	U_1
Finned	Deisobutanizing alkylate	33.5	45	4,041	184	10,700	69.6
Finned	Deisobutanizing alkylate	25.0	52	2,730	176	8,308	57.9
Plain	Deisobutanizing alkylate	44.0	69	4,240	150	25,910	24.6
Plain	Butane splitting	20.6	135	1,330	107	8,130	18.8
Plain	Butane splitting	30.6	83	1,480	241	9,046	40.7
Finned	Butane splitting	26.8	79	4,665	73	12,980	26.1
Plain	Depentanizing alkylate	7.43	46	1,400	115	8,557	18.9

ice, the column was shut down for reboiler cleaning. Photos on pages 149 and 150 show the condition of the tube bundle before cleaning and afterward. Note that conventional methods can clean the outer tubes completely, but the inner tubes cannot be completely cleaned. However, this is normal with any type tube bundle.

One photo shows damage done to the fins by sandblasting. The damage is not considered serious, but it does indicate the need for care during cleaning.

We concluded that the high heat transfer capacity of finned tubes permitting fouling for a longer time before resistance to heat flow became a limitation.

How Do Operations Compare?

Our experience with the LEFU unit led to the installation of more low-fin tube bundles on other fractionating column reboilers. After about a year of operation with four fin tube reboiler bundles, we obtained data on seven columns for comparison of fin and plain tubes. In comparable operations, the actual advantage for finned tubes appears greater than that predicted by calculation. Table I presents plant data on the results of tests made to determine heat transfer characteristics of LEFU reboilers. Over-all coefficients, U_o, shown in this table are based on total outside area. The only direct comparison possible between tube types is for reboilers in deisobutanizing alkylate service.

Over-all heat transfer coefficients of the two finned tube bundles—184 and 176 Btu./(hr.) (sq. ft.) (°F.)—are slightly higher than that of the plain tube bundle—150 Btu./(hr.) (sq. ft.) (°F.). However, when we compare the heat transferred by one foot of pipe, U_1, we find that the finned tubes transferred 2½ times the heat transferred by the plain tubes—69.6 and 57.9 compared with 24.6 Btu./(hr.) (ft.) (°F.). The greater advantage for finned tubes indicated by these data, compared to that expected from the sample calculation on page 151, may be a result of different fouling conditions for the first three operations shown.

The remaining data in the table do not permit direct comparison of fin and plain tubes in identical services, but may be interesting as plant data. On the whole, however, the data imply finned-tube superiority.

The pentane splitting column reboiler has a lower heat transfer coefficient than the other finned tube, kettle type reboilers tested. This low coefficient may be the result of a dirty tube bundle.

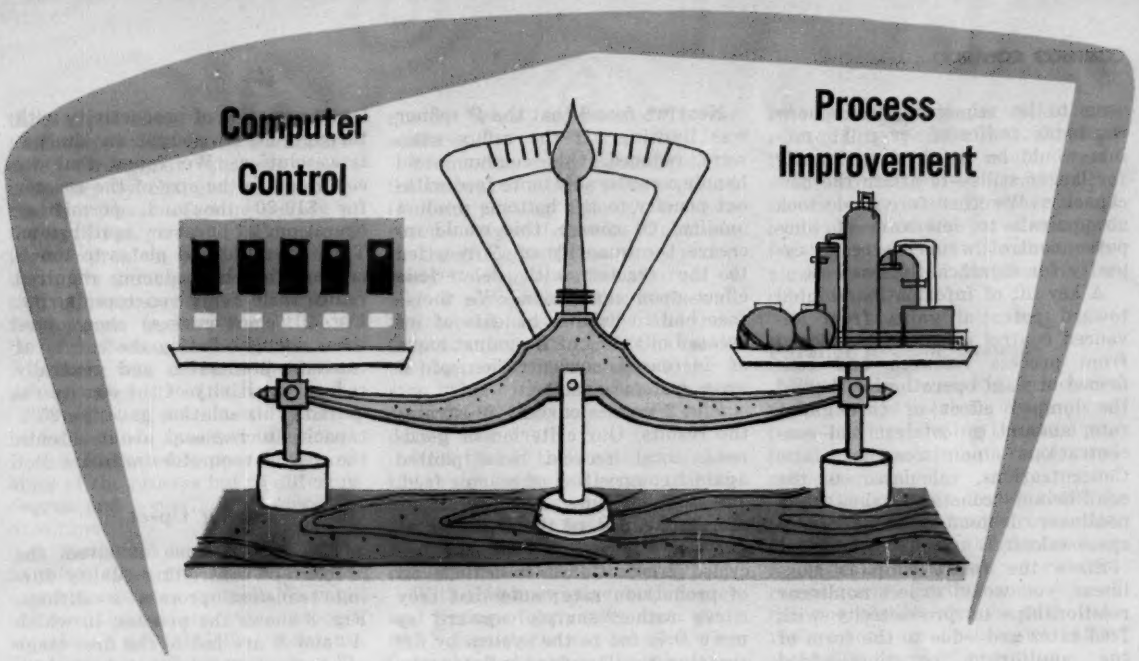
Courage of Our Convictions

As a result of the operating data accumulated over a three-year period, it is now accepted practice at Baytown refinery to fabricate steam reboilers with finned tubes. We specify these as U-tubes on a square pitch to avoid the cost and maintenance of a floating head and to facilitate cleaning.

ACKNOWLEDGMENTS

The author appreciates the inspection and test work done by J. C. Davis of Humble and D. W. McEachern formerly of Humble.

W. O. WEBBER is a graduate of the University of Oklahoma from which he obtained his bachelor's degree in chemical engineering "a good many years ago." He has been with Humble Oil and Refining Co. for 21 years and is now a staff engineer at Humble's Baytown, Tex., refinery. Mr. Webber's present responsibilities include design and development of new control systems. In the past, he has worked on light ends recovery and fractionation, refinery coordination, lube production, economics and advanced instrumentation.



Can Computers Control Your Process?

Analysis necessary for computer control application may reveal cheaper ways to gain similar benefits.

C. R. HALL, E. I. du Pont de Nemours & Co., Newark, Del.

ABOUT six years ago, the business literature was filled with rosy prospects for all through use of electronic data processing. Tremendous data handling speeds and lightning-like calculations of large-scale digital computers were going to quickly revolutionize all business methodology.

There was much talk and publicity about the broad generalities, yet few factual reports of significant accomplishments. Many large organizations, evidently fearful of being left behind, moved quickly to install millions of dollars' worth of equipment and to spend many times this investment in programming, training and testing.

It became evident, however, that economic application of business computers would not come overnight. Those who tried applications found that only carefully planned approaches resulting from thorough analysis would really pay off.

Now there is much general talk of the push-button plant—of digital computers to control vast chemical processes. But secrecy surrounds specific applications; few have published results of accomplishment. Are we going to pass through the same growing pains as before, or are we going to approach the problem of computer-controlled plants rationally, with careful analysis, before leaping to buy equipment? (Despite competition among computer manufacturers, we believe for the most part that they too support thorough analysis before purchase.)

We will here consider three analyses we have made to seek economic value from improved control inherent in application of general-purpose, internally programmed digital control computers. We're talking about a computer to control a medium-sized process or part of a larger process—say about 100-200 inputs (temperature, pressure, flow, etc.) and perhaps 10-25 output control or alarm functions.

This computer system requires an investment for computer of $100-150 thousand, for accessories (transducers, input-output, etc.) of about $50 thousand and for engineering of $50-150 thousand—depending on process knowledge, know-how and accounting methods. Total investment, then, may run from $200-350 thousand. Keep the rough quarter of a million dollar investment in mind as you go through three actual cases.

Catalytic Reactor System

Fig. 1 is a diagram of the first process. Raw materials *A* and *B* join recycled streams and pass through the catalyst bed in the liquid phase. Reactor effluent goes to a still where the tops, product *C* and unreacted *A*, are separated from product *D* and unreacted *B*. Tops and bottoms from this separation still go to separate refining stills for further separation and recycle. The performance of the three stills is the key to product quality. This performance also has strong influence on reactor capacity. If much of products *C* or *D* is recycled to the reactor, reactor performance is seriously affected.

A 25% increase in capacity was

soon to be required. Preliminary estimates indicated over $1 million would be required—primarily for larger stills—to attain the new capacity. We therefore undertook an analysis to determine if computer control would increase capacity for significantly less cost.

A key bit of information pointed toward potential gains from advanced control concepts. Developed from process research and confirmed in plant operation, it showed the lumped effect of throughput rate, amount of catalyst and concentrations upon reaction rate. Concentrations, calculated as the equilibrium constant, showed a nonlinear drop-off with increased space velocity.

Since the relationship is nonlinear, you would expect nonlinear relationships of productivity with feed rates and—due to the form of the equilibrium equation—added nonlinear effects from feed concentration variations.

The recycle load of the stills was found to be the dominant process factor. Too, reactor feed composition is important because of its effect upon subsequent conversion when recycling either product *C* or *D* along with unreacted *A* and *B*. To examine reactor performance under varying conditions of reactants ratio and products concentration in the feed, quantity of recycled unreacted materials was used as a "criterion of goodness."

Next we found that the *D* refiner was limiting. If the reflux ratio were reduced, this column could handle considerably more feed without penalty to the bottoms product quality. Of course, this would increase the quantity of *D* recycled to the reactor with deleterious effect upon conversion. We therefore had to balance benefits of increased quantity of *B* against harm of increased concentration of *D* upon system capacity.

Fig. 2 (white curves) illustrates the results. Our criterion of goodness, total recycle, was plotted against composition of reactor feed. The diagonal lines show capacity—or reflux ratio—of the *D* refiner at varying compositions of the recycled stream. Curves indicate levels of production rate; note that they curve rather sharply upward as more *D* is fed to the system by decreasing the *D* refiner reflux ratio. (The capacity of the *C* refiner could have been shown as a diagonal line on the left going upward to the right in Fig. 2. Operation could not be maintained at low concentrations of *B* in the feed.)

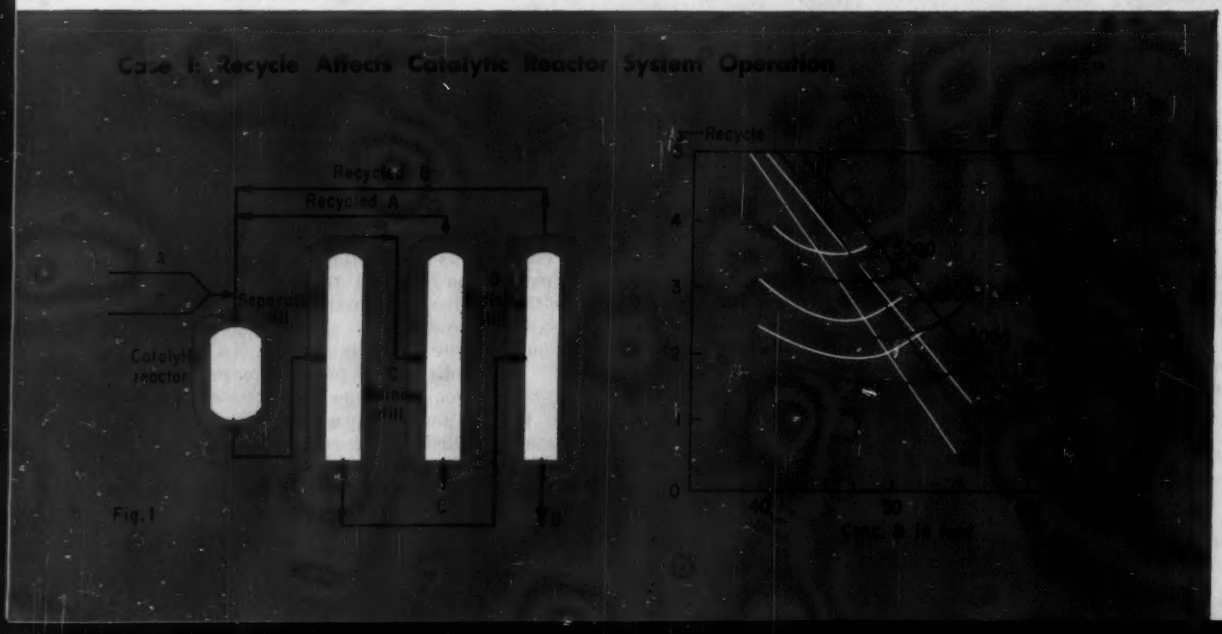
Our study showed that intelligent control of reactor feed mixture by feed control coupled with reflux ratio control could attain the desired increase in capacity and compensate for normal operating fluctuations. Neither refiner would flood to cause system shutdown.

But since the crux of the problem lay in variation of productivity with throughput, we sought an alternative solution. We found that we could double the size of the reactor for $10-20 thousand, permitting operation at nearer equilibrium. Then we could add plates to the *D* refiner, thereby reducing required reflux ratio for given tops purity. Fig. 2 (black curves) shows how these changes flatten the curves of constant production and generally reduce sensitivity of the control required. This solution gave the 25% capacity increase at about a tenth the cost of computer control.

Quality During Upset

The second case involved the problem of controlling quality during transient process conditions. Fig. 3 shows the process, in which *A* and *B* are fed to the first stage of a reactor where temperature and pressure are held constant. The effluent passes to a second reactor stage where pressure is reduced and the reaction driven toward completion. Quality at the second stage outlet is important, because succeeding operations depend on consistent, closely controlled quality considerations. Off-quality product could not be blended or sold—and about $200,000/yr. of scrap was produced.

The operations are perhaps unusual because each operates successfully at only three discrete



throughput rates to make salable finished product. Can we accommodate throughput changes made necessary by changing market demands without affecting quality at the second stage outlet? Complicating the problem, total reactor holdup equals about four hours' production. Changes made in feed ratio, for example, require some time to be fully effective at the reactor outlet; there will be some dead time as well as effects of mixing.

Two quality characteristics must be held within specified tolerances. Both are affected by operating variables of the process but to differing degree and sometimes in opposite directions.

A statistical analysis was made to relate these two characteristics, α and β, to three controllable variables while holding other process variables substantially constant. The three controllable variables (X_1, X_2 and X_3) were throughput rate, second stage pressure and feed ratio of A to B. Two regression equations describe the relationships:

$$\alpha = 49 + 0.9X_1 + 5X_2 + X_3 + 0.7X_1X_3$$

$$\beta = 37 - 2X_1 - 3.1X_2 + 0.7X_3 + 0.6X_1X_2$$

Within the three-dimensional space formed by interaction of the three controllable variables, there are surfaces representing equal quality values. Coordinates of these surfaces show values of the controllable variables required to attain quality levels represented by the surfaces.

From other experimental work on the amount of mixing to be expected in fluid passing through the two reactor stages, dynamics of changes in the three variables on α and β could be approximated. Curves of Fig. 4 represent quality values at the second stage outlet and how they change with time. Change in each variable is assumed to be a step value (instantaneous) at zero time. Solid line represents α and dotted line β.

Note that if the starting point in the three-dimensional space of variable interaction had been different from that chosen for the example of Fig. 4, amplitude of the quality changes would also be different.

With this knowledge, both degree and timing of influences upon quality characteristics caused by throughput change can be calculated directly. For any reasonable throughput change, control equations can be developed for the other two variables, feed ratio and second stage pressure, which will compensate and hold the quality transients within specifications.

On further examination, we found that precise timing and degree of compensating action required was essentially caused by the step change in throughput. If throughput could be changed gradually, only approximate changes in the compensating variables would be required to remain within current quality specifications. Gradual throughput change would create about $20,000/yr. of scrap at the second stage outlet, but we would avoid over $200,000/yr. of scrapped finished product. This solution obviously prohibited justification for computer control.

Parallel Reactor Systems

The third process, Fig. 5, includes eight parallel catalytic reactor systems—each producing the same material, each containing a reactor and condenser.

In the complex liquid catalyst, two of four components are volatile, and the performance of the reactors is critically dependent on catalyst composition. Furthermore, life of the nonvolatiles decays with use: replacement is necessary after about 500 hours of operation.

To maintain continuity of operation, catalyst changes are staggered. Thus, the eight reactor systems—and only seven during catalyst renewal—have catalysts of different ages. Our problem is how to run the complete process at required production and highest yield.

A multiple regression statistical analysis was made on operating data to determine relative influence of variables affecting the process. Two responses—production and yield—were studied.

Fig. 6 shows plots of constant

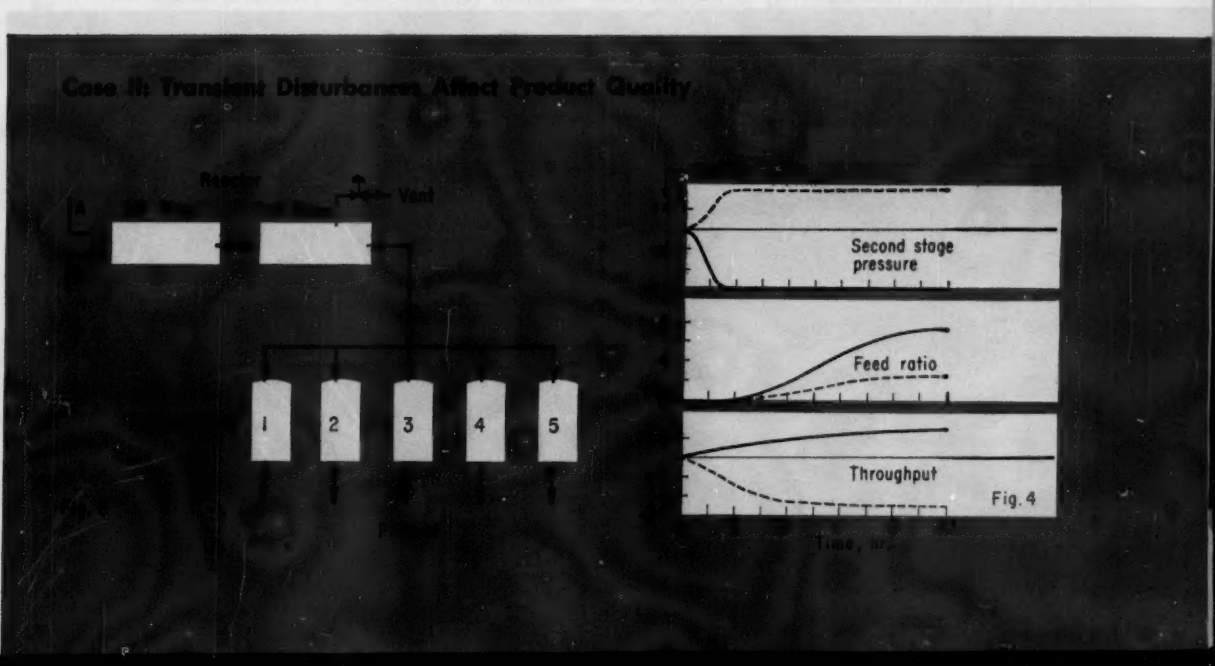


Fig. 4

production rate contours (solid lines) and constant yield contours (dotted lines) for different values of operating temperatures and concentrations of catalyst component *C*. The horizontal rows of plots are for two different values of catalyst component *B*, and the vertical columns of plots are for two different values of catalyst component *A*. Effects of catalyst age requires another set of plots similar to these.

Catalyst components *B* and *C* are volatile to differing degree and their rates of removal dependent on concentrations, temperature and the throughput rate. Their controllability as independent variables depends on knowing their levels and then replacing them when necessary to compensate. Several other variables which influence performance were included in the analysis: reactant ratios, pressure, throughput rate and percent inerts.

Note in Fig. 6 the wide variation of yield for a given production rate and, above all, the interaction between independent variables. One-percent yield improvement is worth over $200,000/yr. of increased profit, so careful examination is worthwhile.

Since there are many variables with complex interactions, operation at maximum profit by human beings would be by chance alone. It seems for this case that the only hope for achieving maximum yield operation—short of coming up with a new process which has only a couple of independent variables—is digital computer control.

We believe this last example indicates the area where computers for control of chemical processes will make their greatest initial mark. It requires all factors of exercising a general-purpose, internally programmed digital computer to the utmost: multiple units, "remembering" status of each unit at all times, computing gradually changing compositions as a result of operations, manipulating controllable variables of each individual unit to compensate for calculated changes of the uncontrollable variables. And all of this is done to make the over-all system produce the required quantity at over-all maximum yield.

What Can We Conclude?

For those who are examining systems for improvement through computer control, we recommend the following:

1. Seek lower cost alternative solutions to your problems every step of the way. Bringing in someone unfamiliar with computer control possibilities is a big help.

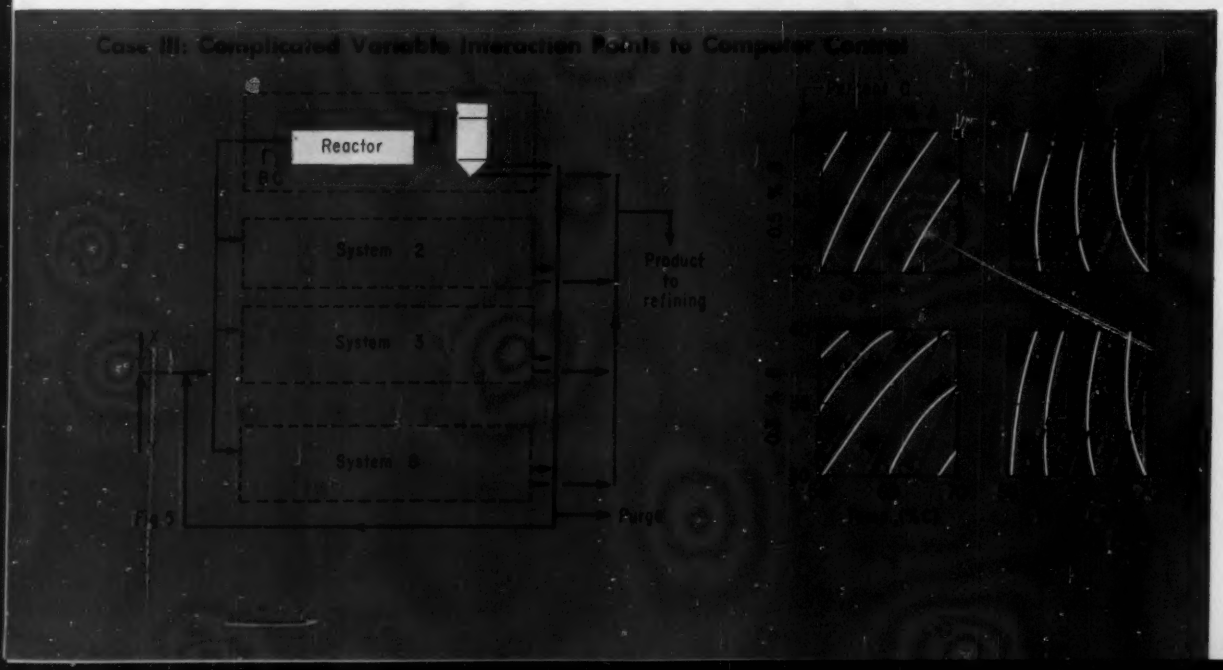
2. Have a strong mathematician or statistician on the team. He must have a degree or practical experience in the sciences as well.

3. Seek situations where there are uncontrollable independent variables, or random upsets, which change fairly rapidly with time *and* where there are two or more controllable independent variables.

4. Look for effects of interaction between independent variables upon results desired. If there is no interaction, there may be no problem.

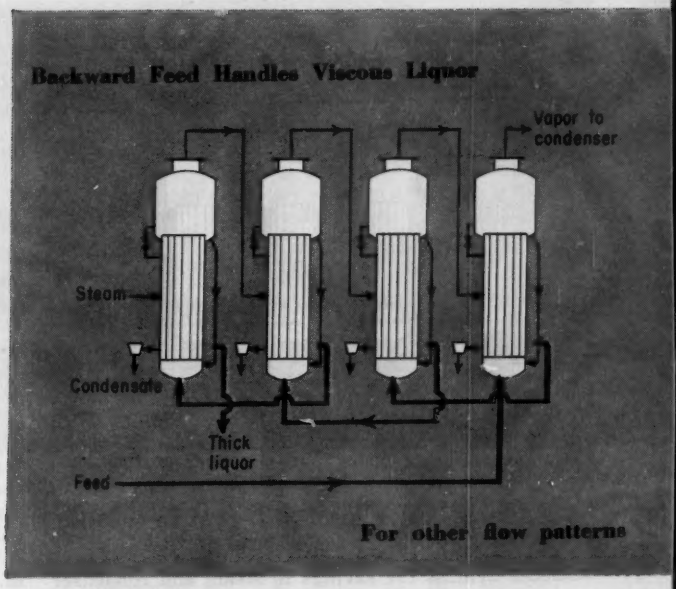
This article is based upon a presentation at the winter general meeting of AIEE, New York, February 1, 1960.

C. R. HALL is on special assignment in Du Pont's engineering department to examine potential computer control applications. A graduate of Ohio State with B.S. and M.S. in chemical engineering, Hall joined company and department in 1947. Prior to his current assignment, he had wide experience in process research and development, project coordination and engineering analysis and computation. During World War II, Hall served on active duty with U.S. Navy submarine service.



C E Refresher

Use simplified method to speed calculations for over-all evaporation rate, heat transfer surface, steam rate and economy.



How to analyze and calculate the performance of . . .

Multiple-Effect Evaporators

JESSE COATES and BERNARD S. PRESSBURG, Louisiana State University, Baton Rouge, La.*

EVAPORATORS in processing operations may operate as single effect or multiple effect. Choice of arrangement reflects steam economy or evaporator capacity. In single operation, the heat supplied in the steam is used only once. Resulting economy, expressed as lb. vapor/lb. steam, is very poor and is about 0.8 for a cold feed. However, capacity is usually highest for single effect operation and is expressed as vapor weight per unit time for a unit heat transfer area.

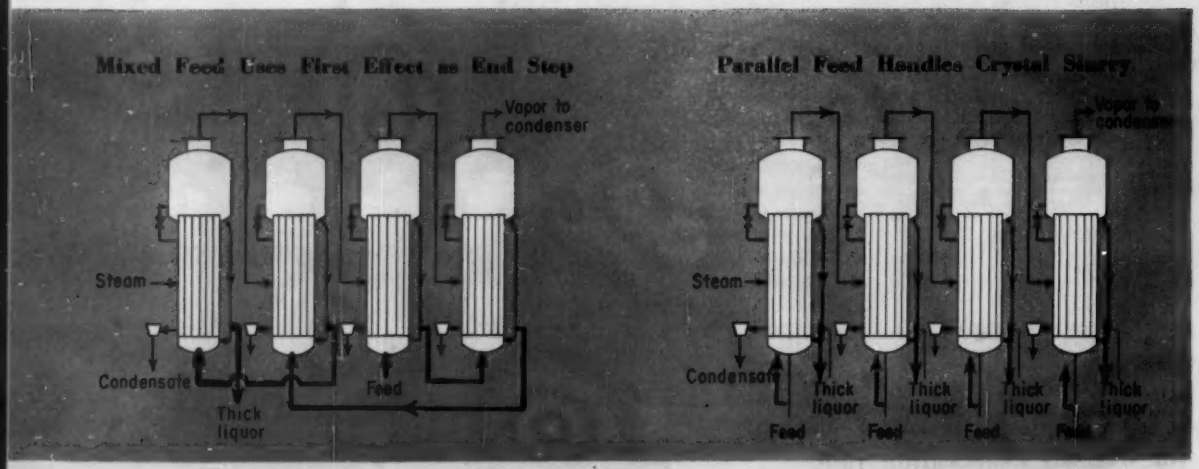
In multiple effect operation, several evaporators are connected by appropriate piping so that vapor passes from one effect to the next in series. Hence, the heat supplied to the first effect is used to vaporize water in the first effect. This vapor, in turn, passes to the next effect until finally the heat in the vapor supplied to the last effect passes to the condenser. The net result of this arrangement is multiple re-use of heat and a marked increase in the economy of the system. A rough approximation of the economy can be obtained by multiplying the number of effects by 0.8.

In addition to the saving in steam, there is also a saving in cooling water required to operate the last effect condenser. In the absence of detailed calculations a good rule-of-thumb is that about 30 lb. of cooling water must be provided for each lb. of steam supplied to the first effect. Sole advantage of multiple effect operation is the increased economy accompanied by the savings in steam and cooling-water consumption for a given capacity.

We have already seen how the boiling point elevation[1] reduces the effective temperature drop for heat transfer. In multiple effect operation, this drop is cumulative. Thus, the effective total temperature drop is equal to the total over-all temperature drop from the steam supplied to the first effect to the condensing temperature of the vapor from the last effect minus the sum of the boiling point elevations in all effects. This reduction in the effective temperature drop decreases the capacity.

In a multiple effect system, the evaporators are connected in series. Consequently, any increase in the number of effects increases the resistance to heat transfer and decreases the capacity which is measured as lb. vapor/sq. ft. This means an increased investment to secure the same capacity for multiple effect as for single effect. Increased investment must be

* To meet your authors, see *Chem. Eng.*, May 18, 19[illegible], p. 181



balanced against the savings in steam and condenser water.

Analyze Evaporator Calculations

In evaporator calculations, three relations must be satisfied: (1) material balance, (2) heat balance and (3) heat transfer rate equation. These relations must be applied to each evaporator in a multiple effect system and to the entire system as a whole.

Many multiple effect systems of operation are possible. Some are shown in the figures. The method of calculation is basically the same for each system. A simple forward-feed triple-effect system as shown on p. 160 will be used to demonstrate the method. First an over-all material balance on the entire unit and on the individual bodies must be made. The material balances are given in the figure. Over-all material balance:

$$F - P = \Sigma E = E_1 + E_2 + E_3 + \cdots \quad (1)$$

Product rate:

$$P = N_F F / N_P \quad (2)$$

Total evaporation from all effects:

$$\Sigma E = F\left(\frac{N_P - N_F}{N_P}\right) \quad (3)$$

Material balances for each effect are written to obtain the concentration of the liquor leaving the effect.

$$N_1 = \frac{F N_F}{F - E_1} \quad (4)$$

$$N_2 = \frac{F N_F}{F - E_1 - E_2} \quad (5)$$

An equation similar to Eq. (5) can be written for each succeeding effect.

The heat balance on each effect is written. These heat balances are best written in terms of enthalpies if an enthalpy-concentration diagram is available. However, such charts are not always available. Since we have explained the method[1] of calculating latent heats of water, the heat balance equations can be written without recourse to the enthalpy-concentration diagrams.

For Effect 1:

$$S\,\lambda_s = F\,C_F\,(t_{L1} - t_F) + E_1\,\lambda_{L1} \quad (6)$$

For Effect 2:

$$E_1\,[C_{V1}\,(t_{L1} - t_{V1}) + \lambda_{V1}] = E_2\,\lambda_{L2} - (F - E_1)\,C_{L1}\,(t_{L1} - t_{L2}) \quad (7)$$

For Effect 3:

$$E_2\,[C_{V2}\,(t_{L1} - t_{V2}) + \lambda_{V2}] = E_3\,\lambda_{L3} - (F - E_1 - E_2)\,C_{L2}\,(t_{L2} - t_{L3}) \quad (8)$$

Also, the heat transfer equations are:

$$q_1 = U_1 A_1 \Delta t_1 = U_1 A_1 (t_s - t_{L1})\,S\,\lambda_s \quad (9)$$

$$q_2 = U_2 A_2 \Delta t_2 = U_2 A_2 (t_{V1} - t_{L2}) = E_1\,[C_{V1}\,(t_{L1} - t_{V1}) + \lambda_{V1}] \quad (10)$$

$$q_3 = U_3 A_3 \Delta t_3 = U_3 A_3 (t_{V2} - t_{L3}) = E_2\,[C_{V2}\,(t_{L2} - t_{V2}) + \lambda_{V2}] \quad (11)$$

In general, use the steps outlined in the following procedure to solve these equations.

Step 1—An initial estimate of the temperatures in each effect is made. In making this estimate, use the rough approximation of equal heat transfer rates in each effect.

$$U_1 A_1 \Delta t_1 = U_2 A_2 \Delta t_2 = U_3 A_3 \Delta t_3 \quad (12)$$

$$\Sigma \Delta t = \Sigma \Delta t' - \Sigma BPE = \Delta t_1 + \Delta t_2 + \Delta t_3 \quad (13)$$

$$\frac{\Sigma \Delta t}{\Delta t_1} = 1 + \frac{U_1 A_1}{U_2 A_2} + \frac{U_1 A_1}{U_3 A_3} + \cdots\cdots$$

Note that only the ratios of the areas need be known and not the actual areas. These can be defined as $R_{A2} = A_2/A_1$ and $R_{A3} = A_3/A_1$. In most cases these area ratios are equal to unity but this is not necessarily so.

$$\frac{\Sigma \Delta t}{\Delta t_1} = 1 + \frac{U_1}{U_2 R_{A2}} + \frac{U_1}{U_3 R_{A3}} \quad (14)$$

Use Eq. (14) to estimate Δt_1. From this $t_{L1} = (t_s - t_1)$.

Temperatures in the other effects are evaluated in a similar manner. Thus:

$$t_{V1} = t_{L1} - (BPE)_1$$
$$\Delta t_2 = U_1 \Delta t_1 / U_2 R_{A2} = (t_{V1} - t_{L2}) \quad (15)$$

$$t_{V2} = t_{L2} - (BPE)_2$$
$$\Delta t_3 = U_1 \Delta t_1 / U_3 R_{A3} = (t_{V2} - t_{L3}) \quad (16)$$

Remember that these are rough estimates and as such serve as initial assumptions for solving Eqs. (6), (7) and (8). Having made an estimate of the temperatures and concentrations in each effect, then the latent heat of vaporization λ_L is evaluated by the methods already described. Heat balance equations and over-all material balance equations are then solved simultaneously for E_1, E_2, E_3, . . . E_n.

Step 2—Solve heat transfer Eqs. (9), (10) and (11) for the areas. Required area ratios are then checked. In most common applications area ratios are unity.

Step 3—If the calculated area ratios do not check, make new estimates of the values of Δt for each effect. This can be done by using the previously calculated areas as a guide. If the calculated area is too large, then Δt should be increased for that effect and vice versa.

Step 4—Using the values for E_1, E_2 and E_3 from Step 1, make new estimates of the concentration in each effect. Using these new concentrations and values of Δt from Step 3, get new values for boiling point elevations and temperatures in each effect.

Step 5—Solve heat balance equations for more correct values of E_1, E_2 and E_3. Even though poor initial assumptions were made, these new values will be very close to those obtained in the initial series of calculations.

Step 6—Solve the heat transfer equations for the areas in each effect and check the area ratios. If necessary, repeat the whole process but usually the second trial gives satisfactory results.

In summary, the usual method requires solving the various equations by successive approximations. This is not difficult but it can be time consuming and tedious.

Use a Simplified Method

Much of the time required for making these calculations can be saved by recognizing that in a multiple-effect evaporator heat is being transferred from the source through the evaporators in series. Finally, the heat is discharged to the cooling water supplied to the condenser which receives the vapor from the last effect. Thus, the series resistance concept can be employed here:

$$\Sigma q = \Sigma \Delta t / R_{total} \quad (17)$$

A convenient way for evaluating the terms in Eq. (17) was developed by Coates.[3] The key equations are:

$$\Sigma q = \lambda_{av} \Sigma E \quad (18)$$

$$\lambda_{av} = \frac{F C_F (t_{L1} - t_F)}{\Sigma E} + \frac{\lambda_{L1}}{b} \quad (19)$$

In Eq. (19), t_{L1} is the temperature of the liquor in the effect the feed enters regardless of whether it is the first effect or not. The factor b equals $(1 + 0.1n)$ for the forward feed case and may be taken as unity for all other cases.

$$R_{total} = 1/U_e \Sigma A \quad (20)$$

$$\lambda_{av} \Sigma E = U_e \Sigma A \Sigma \Delta t \quad (21)$$

$$\Sigma A = A_1 (1 + R_{A2} + R_{A3} + \ldots) \quad (22)$$

The effective coefficient is obtained from:

$$\frac{U_1}{U_e} = \left(\frac{1 + R_{A2} + R_{A3} + \ldots}{n} \right) \left(1 + \frac{U_1}{U_2 R_{A2}} + \frac{U_1}{U_3 R_{A3}} \right) \quad (23)$$

Where the area ratios are equal to unity, the term $(1 + R_{A2} + R_{A3} + \ldots)$ is equal to n and Eq. (23) becomes:

$$\frac{1}{U_e} = \frac{1}{U_1} + \frac{1}{U_2} + \frac{1}{U_3} + \ldots \quad (24)$$

Steam consumption is estimated from the heat transferred in the first effect,

$$q_1 = \Sigma E \left[\lambda_{av} - \lambda_{L1} (n - 1)/n \right] \quad (25)$$

Eq. (25) gives the steam consumption in the first effect even though λ_{L1} is evaluated at the conditions existing in the effect the feed enters. Having obtained q_1, steam consumption is calculated from

$$S = q_1 / \lambda_s \quad (26)$$

The economy $\Sigma E/S$ is then easily obtained.

The following problem taken from McCabe and Smith[5] with slight modification illustrates application of this method.

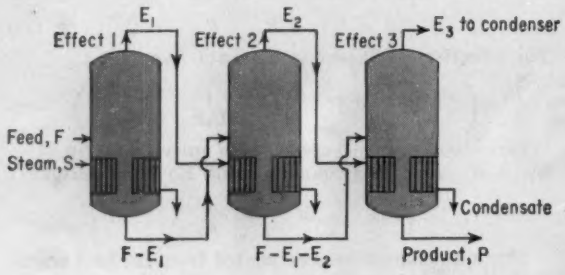
A solution with a negligible boiling point elevation is to be concentrated from 10 to 50% solids in a triple-effect evaporator. Steam is available at a gage pressure of 15 psi. and 249 F. Absolute pressure in the third effect is 4 in. Hg and corresponds to a boiling temperature of 125 F. Feed enters at a rate of 55,000 lb./hr. and 70 F.

Specific heat of the solution may be taken as 1.00 Btu./(lb.) (°F.) at all concentrations. Over-all coefficients in Btu./(hr.) (sq. ft.) (°F.) are estimated to

Nomenclature

A	Area, sq. ft.
BPE	Boiling point elevation.
C	Specific heat, Btu./(lb.) (°F.).
F	Evaporation rate, lb./hr.
F	Feed rate, lb./hr.
N	Effect.
n	Number of effects.
N_F	Weight fraction of solute in feed.
N_P	Weight fraction of solute in product.
P	Product rate, lb./hr.
q	Heat rate, Btu./hr.
R	Total resistance as defined by Eq. (20).
S	Steam consumption, lb./hr.
t	Temperature, °F.
U	Over-all heat transfer coefficient, Btu./(hr.) (sq. ft) (°F.).
Δt	Temperature difference, °F.
$\Delta t'$	Over-all temperature difference from steam to condenser, °F.
λ	Latent heat, Btu./lb.
Σ	Sum of.
Subscripts	
1, 2, 3	Effect number.
F	Of the feed.
L	Of the liquor.
s	Of the steam.
V	Of the vapor.

Trace Flow Patterns for Forward Feed



be 550 in the first effect, 350 in the second and 200 in the third with forward feed. For backward feed, the corresponding coefficients are 450, 350 and 275. Each effect is to have the same heating surface.

Calculate the amount of heating surface, the steam consumption and over-all economy (a) with forward feed and (b) with backward feed.

Analysis of Problem

We find over-all evaporation rate E by substituting in Eq. (3) which gives 44,000 lb./hr. Since boiling point elevations are negligible, it is not necessary to calculate the concentrations of the liquor in each case. Since the areas are equal, we find R_{A2} equals R_{A3} and each has a value of one.

Forward feed case:

From Eq. (14) we estimate Δt_1 and then calculate t_{L1}.

$$\frac{\Sigma \Delta t}{\Delta t_1} = 1 + \frac{550}{350} + \frac{550}{200} = 5.32$$

Since boiling point elevations are negligible,

$$\Sigma \Delta t = (249 - 125) = 124 \text{ F.}$$
$$t_{L1} = 249 - (124/5.32) = 225.7 \text{ F.}$$
$$\lambda_{L1} = 961.4 \text{ Btu./lb.}$$

Substituting appropriate quantities in Eq. (19) gives the average latent heat λ_{av} as 1,127.5 Btu./lb. From Eq. (23), we find the ratio of U_1/U_v is 5.32. Since the over-all coefficient for the first effect is 550, U_v equals 550/5.32 or 103.4 Btu./lb.

We can now find the total heating surface required for the evaporators by substituting appropriate quantities in Eq. (21) to give an area of 3,860 sq. ft. Since each effect is to have the same heating surface, area per effect is 1,287 sq. ft.

Substituting in Eq. (25) gives 21.45 million Btu./hr. as the heat transferred in the first effect. At 249 F., the latent heat of steam is 946 Btu./lb. Hence, steam consumption S is 22,750 lb./hr. Over-all economy of the evaporator is 44,000/22,750 or 1.93 lb. evaporated/lb. steam. A better estimate of Δt_1 can now be obtained by using Eqs. (17) and (20).

$$\Delta t_1 = \frac{21{,}450{,}000}{550 \times 1{,}287} = 30.3$$

Hence, t_{L1} equals (249 − 30.3) or 218.7 F.

McCabe and Smith[3] after several trials by the usual method using simultaneous equations obtained:

$A_1 = A_2 = A_3 = 1{,}202$ sq. ft./effect
Over-all economy = 1.96 lb. evaporated/lb. steam
Steam consumption $S = 22{,}450$ lb./hr.
$t_{L1} = 217$ F.

The simplified method gives a somewhat high value for the area when the feed is cold but all answers compare well with those obtained by the usual method.

Backward feed case:

In backward feed, the feed enters the last effect and the concentrated product leaves the first effect. In Eq. (19), t_{L1} is 125 F. and λ_{L1} is 1,022 Btu./lb. Hence, average latent heat as computed from Eq. (19) is 1,090.7 Btu./lb.

From Eq. (24), we calculate the ratio U_1/U_v and find it to be 3.923. Hence, effective over-all coefficient U_v equals 450/3.923 or 114.8 Btu./(hr.) (sq. ft.) (°F.). Substituting in Eq. (21) gives total heating surface of 3,390 sq. ft. or 1,130 sq. ft./effect.

Heat transferred in the first effect is obtained from Eq. (25) even though λ_{L1} and t_{L1} are for last effect conditions. Substituting appropriate values in Eq. (25) gives 18.35 million Btu./hr. for the heat transferred. Dividing the heat transferred by latent heat of steam at 249 F. gives steam consumption of 19,400 lb./hr. Over-all economy is 44,000/19,400 or 2.26 lb. evaporated/lb. steam. A better estimate for t_{L1} now gives:

$$t_{L1} = 249 - \frac{18{,}350{,}000}{450 \times 1{,}130} = 213 \text{ F.}$$

By the exact method, McCabe and Smith[3] obtained:

$A_1 = A_2 = A_3 = 1{,}151$ sq. ft./effect
$S = 19{,}150$ lb./hr.
Economy = 2.30 lb. evaporated/lb. steam
$t_{L1} = 214$ F.

Again the results check well with those obtained by the exact method. This problem is not intended to show the comparative performance of forward and backward feed. It shows only the method of calculation.

We have worked many problems by this method and have found similar checks. For moderately warm feed —the usual case—the results differ from those obtained by the exact method by about 2%. Maximum error found in any case studied was about 7.5%.

This method should not be applied directly to systems in which steam is withdrawn from the vapor line between one or more of the evaporators of a multiple-effect system. Radiation losses should be allowed for after application of this method.

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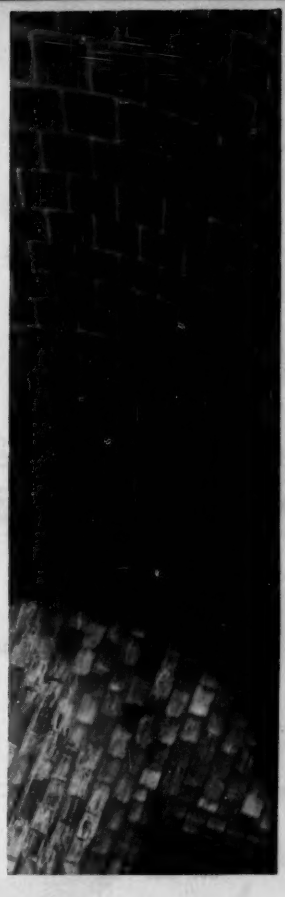
3. McCabe, W. L., J. C. Smith, "Unit Operations of Chemical Engineering," McGraw-Hill, New York, 1956.

Designing Details Of Brick-Lined Process Equipment



This second of two articles applies the basic principles put forth last month to design of details, to construction procedures and tests.

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YOU can think of any brick-lined process vessel as consisting essentially of a tank to which a variety of attachments such as gas diffusers, packing supports and packing, bubble trays, recirculating legs, and the like, may be added.

In the first part of this article (p. 129, Feb. 22, 1960) we discussed the basics of design and the common construction materials including the brick, the cements and the membrane materials, together with materials for accessories such as plastics, graphite, glass and resistant metals.

In the present article we shall consider the wide range of combinations and shape possibilities that are available and shall look at some examples.

Some Do's and Don'ts

In supplementing the basic tank by additions a few fundamental principles govern. These are:

• Avoid need for entry into the vessel for maintenance. Most brick linings after use, particularly those made with silicate cement, retain within the porous structure enough of the vessel contents to make fresh-air masks necessary for maintenance or repair operations. For example, gas diffusers requiring periodic replacement, when inserted from the outside, avoid this disadvantage as compared with those replaced from the inside.

• Minimize nozzles. For example, you can frequently combine several instrument connections on one nozzle. Wherever possible, place nozzles in the gas phase at the top of the tank since leaks in that location are usually easier to tolerate and control. Obviously, you can carry the reduction of nozzles too far, but examine the need for each carefully and don't overlook the possibility of combining connections.

• Evaluate carefully the need for manholes in the two most useful locations, i.e., top head and lower side; construction and maintenance is facilitated by both. However, the lower manhole is in the liquid phase and its intersection with the vessel lining is more complicated. In consequence, it is more vulnerable to liner cracking and leakage. For most applications, the balance of factors favors eliminating the lower manhole and using a larger top manhole only.

• Evaluate carefully the probability of replacement. A strong, less-resistant metal requiring replacement twice a year may make a more dependable gas diffuser than a more resistant plastic or ceramic material of inferior mechanical strength, liable to unpredictable breakage in service.

• Keep the design geometrically simple. Complicated construction often leads to trouble.

• Avoid local zones of higher temperature, at a gas inlet nozzle, for example. In such a case, insert a pipe sleeve, possibly of a resistant metal, through the nozzle to provide a temperature gradient to the nozzle liner proper.

Attachments and Additions

Gas Diffusers—These come in three general categories: radial and spoke types and packing diffusers.

Radial Type—One or two to perhaps eight or more drilled tubes inserted from the outside through nozzles into the shell (Fig. 1).

Advantages: Ready replacement from the outside. Drilling readily changed.

Disadvantages: Multiplicity of nozzles required. This puts a premium upon good nozzle construction.

Requirements: Gas inlet piping to diffusers must be of resistant materials back to a point at least above the liquid level (higher if gas is absorbed by the liquid). Diffuser tubes must have sufficient strength to resist breakage under vibration

To meet your author see Part I of this series, p. 129, Feb. 22, 1960.

Photo in this article and Part I courtesy of Chemical Linings, Inc., Watertown, N. Y.

Radial Diffuser

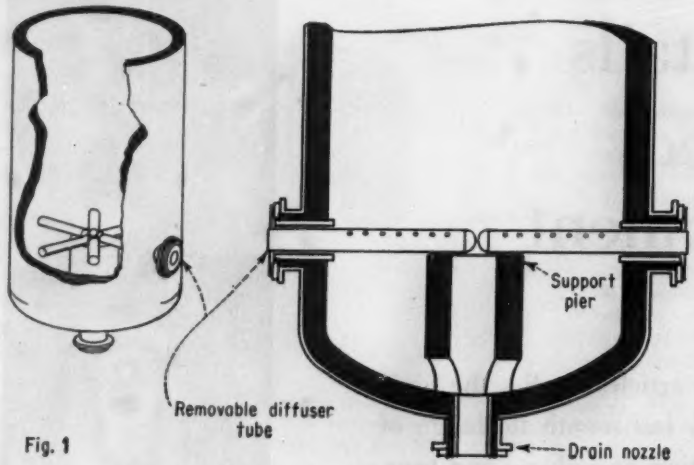

Fig. 1

Spoke-Type Diffuser

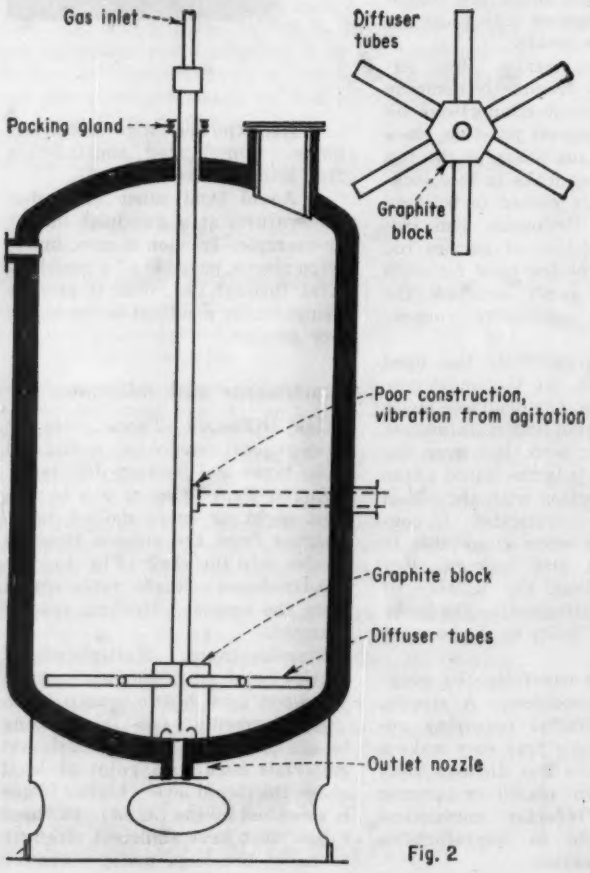

Fig. 2

sometimes associated with gas diffusion. They deserve support from brickwork at their outboard ends.

Spoke Type—Four to eight or more drilled or porous tubes cemented or screwed into a central hub mounted in the bottom of the tank (Fig. 2). Usually made of Haveg or graphite, with a gas entry pipe led down from above through a nozzle in the top head.

Advantages: Only one nozzle is required, and that in the gas phase.

Disadvantages: Not readily repaired, replaced or altered by drilling. May require the top manhole located off-center to permit having the gas pipe on center.

Requirements: Mounting at the bottom of the tank must be secure to prevent movement from agitation. The gas entry pipe may need to be oversize, particularly in tall tanks, for sufficient strength to avoid breakage.

Packing Diffuser—Packing in graduated sizes placed in the bottom of the tank or on a packing support plate (Fig. 3). Best adapted to small towers.

Advantages: Simplest means of dispersing gas in bottoms of packed towers.

Disadvantages: Gas distribution may not be as uniform as in other diffusers. Fine packing may ulti-

Packing Diffuser

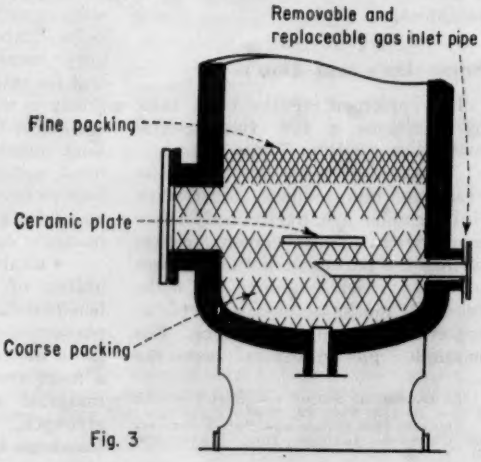

Fig. 3

Locked-In Partition

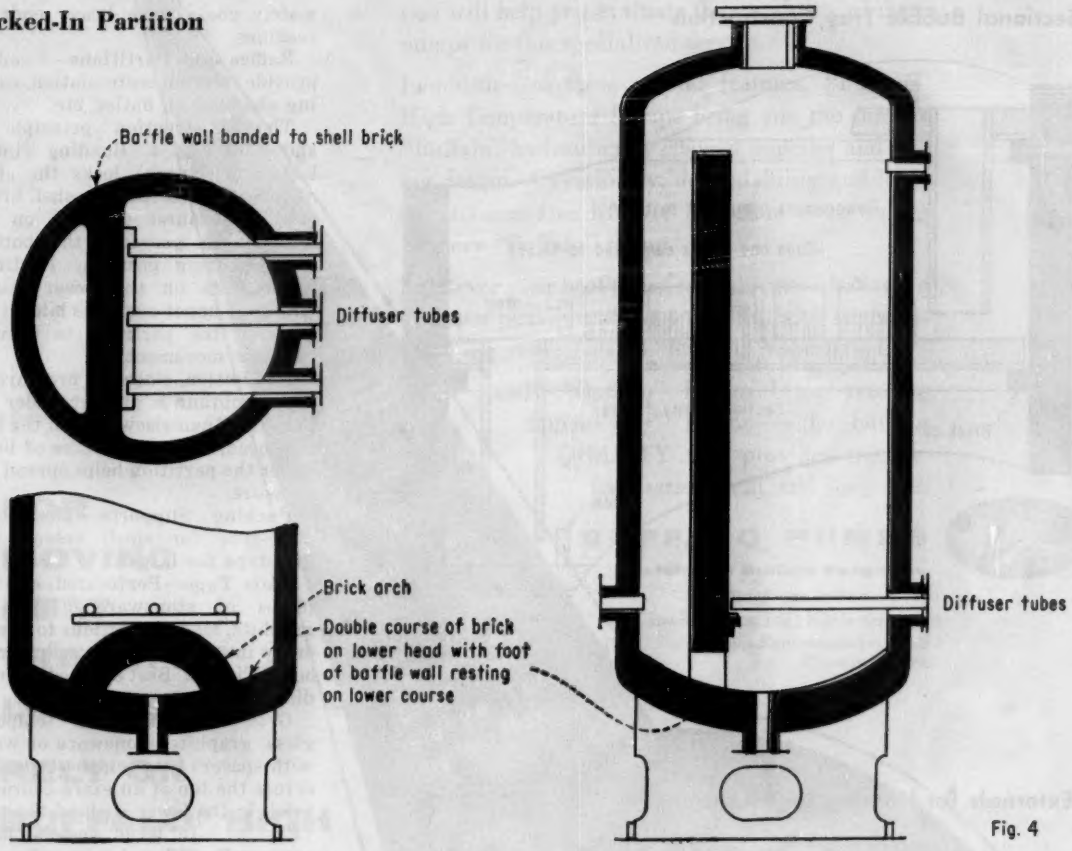

Fig. 4

Grid and Plate-Type Packing Supports

Large Vessels:
Bars of glass, graphite, stoneware, etc. with spacers at ends.
Brick crosswall with arch. (Also with two crosswalls in larger vessel.)

Small Vessels:
Perforated sectional plates of stoneware, graphite, etc.

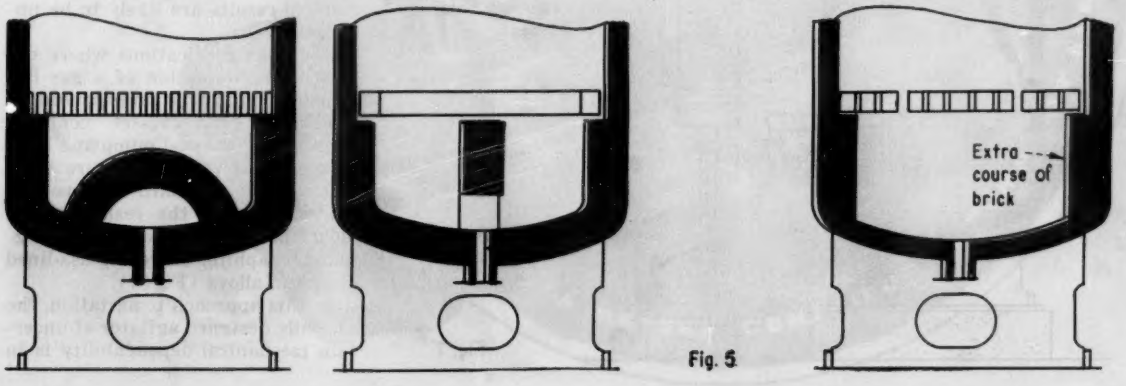

Fig. 5

Sectional Bubble Tray Construction

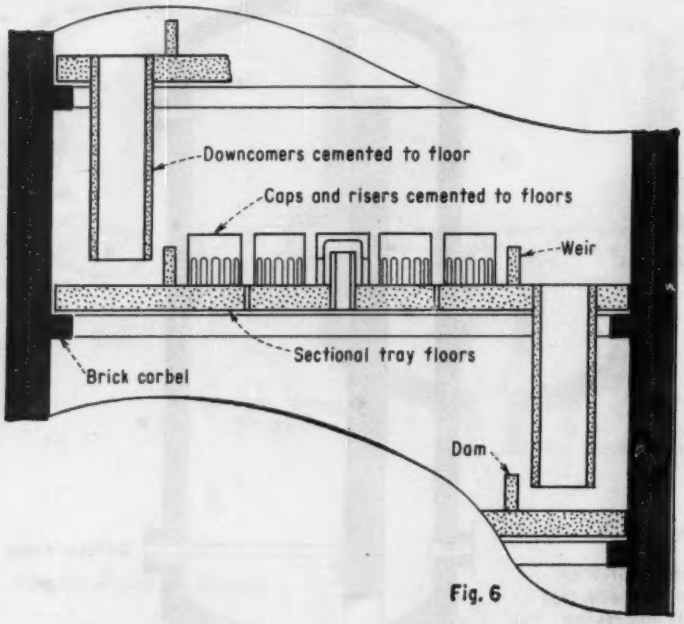

Fig. 6

Externals for Heating and Agitating

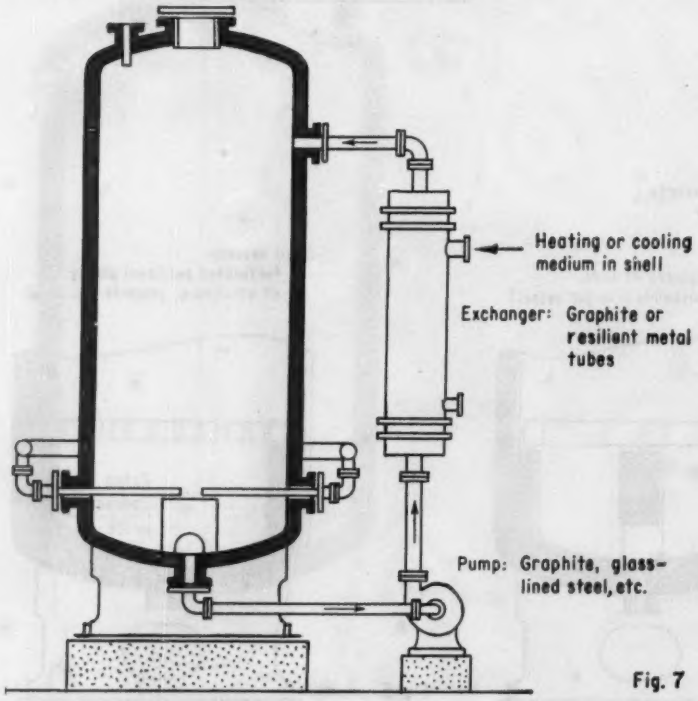

Fig. 7

mately choke with heavy ends or residues.

Baffles and Partitions—Used to provide internal recirculation, calming chamber on outlet, etc.

The construction principle is shown in Fig. 4. Bonding (interlocked brickwork) locks the sides of the partition into the shell brick. A double course of brick on the lower head prevents the bottom from shifting position. Partition brick rests on the lower course while the upper course is laid to the sides of the partition to prevent sidewise movement.

In addition, since the pressure on the membrane is greater under the partition than elsewhere on the bottom head, the extra course of brick under the partition helps spread the pressure.

Packing Supports—These are plate-type for small vessels and grid-type for large.

Plate Type—Perforated, circular plates of stoneware, Haveg or graphite, made in sections to permit entry into the tank through a manhole (Fig. 5). Best adapted to small diameter towers.

Grid Type—Bars of tempered glass, graphite, stoneware or wood, with spacers between the ends, laid across the top of an extra course of brick in the lower shell of the tank (Fig. 5). In large vessels, brick cross walls and arches may be used to pick up the weight of the grid and packing in the middle.

Bubble Trays—Tray floors of graphite or Haveg, caps and risers of graphite or Haveg cemented or screwed to floors. Tray construction is sectional to permit installation through the manhole. Trays usually rest on brick corbels (Fig. 6).

Agitation and Heat Exchange—Construction of both agitators and heat exchange surface within a brick-lined vessel is usually difficult and the results are likely to be undependable.

For most applications where the internal recirculation of a gas lift is insufficient, agitation produced by circulating the vessel contents through an external pump and back to the vessel will prove more feasible. Many standard pumps are available in all the resistant materials including stoneware, impregnated graphite, Haveg, glass-lined steel and alloys (Fig. 7).

In this approach to agitation, the specially designed agitator of uncertain mechanical dependability is in

effect replaced by a ready-made pump of proved performance.

You can take the same approach (Fig. 7) to provide for heat exchange. Standard exchangers of proven design are available in impregnated graphite, glass and resistant metals. By including such a unit in the external recirculating line, heat exchange is readily provided.

An additional advantage of the standard pump and exchanger installation is ready replaceability with minimum down-time.

Design Limitations

In developing a design for a brick-lined vessel, certain limitations of construction and materials should be kept in mind. Some of these are:

Scaffolding is needed inside a vessel from which the masons can work. This is extended as the work proceeds, level by level. Brick under the top head are shored in place by struts erected from the top of the scaffold.

As the top head is finished off, it must always be possible, of course, for the masons to enter and leave the vessel—and also for the scaffolding to be subsequently dismounted and removed.

Advantages of having only a top manhole have been mentioned. In almost all cases you can successfully handle scaffolding and installation in vertical vessels through the top manhole alone.

Internals are built in place after the brick lining is completely installed and scaffolding removed. A second scaffolding of different shape may be required for this installation, and it must be possible to remove this scaffolding also at the end of the work.

At times, finishing touches to an interior installation can be done from a ladder through the top manhole, or from a "bos'n's chair." Scaffolding requirements sometimes limit the shape of internals, and these must be kept in mind during design.

Horizontal vessels require scaffolding from which to shore brickwork in the upper half. Although the lining becomes a self-supporting arch when completed, cavities between the brickwork and shell are prone to occur in the upper half of horizontal tanks unless shoring of the brick is frequent and thorough.

Construction Precautions

Cavities between brick lining and membrane permit convection currents which subject the membrane to far more severe attack than from the ends of capillary channels alone. Cavities also permit the membrane to swell. This means that every precaution must be taken to prevent cavities, both at the back of, and between, the brick.

To insure solid joints and the absence of cavities, it is necessary to use mortar of the right mix and fluidity. Each brick as installed should be well buttered on the end, bottom and back, and shoved firmly into place until excess mortar squeezes from the joints.

Cements are chemical-hardening, with a short life after mixing. Make up only small batches and then watch carefully for signs of initial set. Never allow mixes to stand over lunch breaks or other work interruptions.

Have steel shells properly prepared for applying membranes by:

- Grinding welds smooth.
- Grinding all corners.
- Complete pressure testing.
- Sand blasting the surface.

After installation, test the membrane for leaks by an electrostatic tester. A pinhole occurring at a cavity between membrane and brick will add buckling from the gas pocket formed to all the other disruptive effects acting on the membrane at this point.

Swelling, usually associated with the beginning stages of chemical attack, is the principal limitation in the application of plastic materials. This makes it advisable to confine their use to replaceable components, and where dimensional change will not disrupt adjacent materials. Holes in a plastic gas diffuser, for example, may gradually get smaller.

Thermal shock is the principal limitation of ceramic materials.

Testing Your Materials

Tests under installation conditions, at least on a brief scale, should always be attempted when experience with similar conditions and designs is not available. Cost of simple testing is negligible when compared with the consequences of improper specification or design.

Begin testing by laying-up six or eight bricks with the chosen cement against a steel plate on which the proposed membrane has been applied. After hardening, break the brickwork apart and examine it for completeness of set of the cement, bond between brick and cement and cavities in either. The bond with brick should be great enough so that some mortar clings to the brick when a composite construction is broken.

Also test laminates by this making-and-breaking procedure. Watch for cleavage between resins and glass cloth, as well as any other evidence that foreign material on the cloth is inhibiting the set of the cement, or the bond between cloth and resin. If you are applying laminates to a steel backing, surface preparation should be the same as that proposed for the vessel itself.

Apply similar testing to graphite or plastic materials, if intended for assembly with cements, to the hub construction of nonlap nozzles and to any other materials or assemblies in the proposed design. In all testing, make sure materials and procedures are identical with those intended for final use.

Examine resin cement constructions carefully for completeness of hardening. The set is effected by a combination of heat and catalyst (usually acid in action). Incomplete curing can result from a deficiency of either. Conversely, too much heat or catalyst results in a porous structure.

Materials with which resin cements are sometimes used, such as compressed asbestos, frequently have enough alkalinity to neutralize the catalyst and inhibit curing. Washing such materials with dilute acid and drying carefully usually corrects the difficulty.

Glass cloth sometimes has a film of oil which reduces the bond in laminated constructions. This must be removed by steaming and drying.

Service testing is a final stage in the test procedure, This consists in exposing small samples remaining after the destruction step to approximate service conditions in laboratory equipment. Such testing is by no means definitive, since exposure (particularly of surface) is widely different from actual installation conditions.

Also, many large-scale operating conditions aren't reproduced on the pilot scale. Nevertheless, cost of such testing is minor and the results, if interpreted with judgment, are almost always indicative.

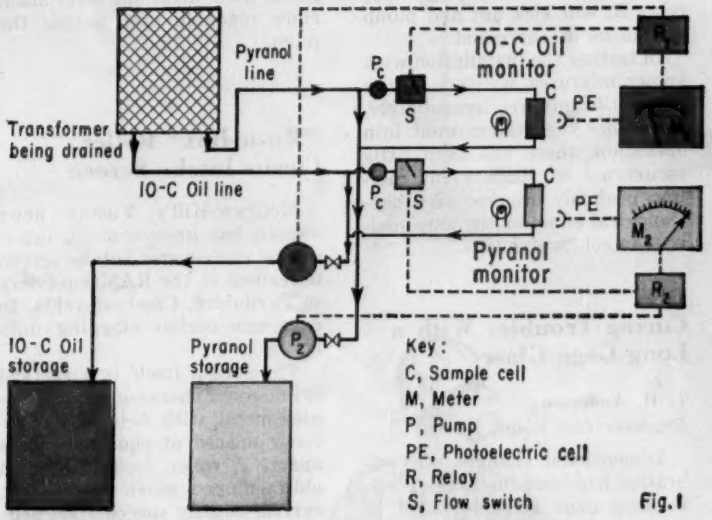

Fig. 1

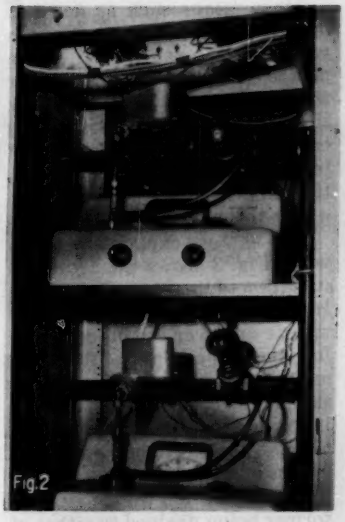
Fig. 2

Colorimeters Watch for Wrong Connection

To prevent any chance of mixing two dielectric liquids, these engineers rigged up a pair of colorimetric "watchdogs" to distinguish between them.

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Materials and Processes Engineering Lab, Medium Transformer Dept., General Electric Co., Rome, Ga.

Quite often, in process operations, the problem arises of preventing inadvertent mixing of liquids being run to storage. The General Electric Co. and other transformer makers encounter this problem when it's necessary to drain the liquid dielectric from a transformer undergoing testing, due to the liquid's failing to meet specifications.

Several liquids can be used—in our case, a mineral hydrocarbon oil known as 10-C, and a nonflammable chlorinated hydrocarbon called Pyranol.* If these fail to meet specs and are drained and stored for reclamation processing, it's essential that they not be mixed. Subsequent separation would not be practical, and even small quantities of one material in the other have very adverse effects on the desired properties of each.

To prevent the possibility of pumping the dielectric liquid drained from a transformer into the wrong storage tank we developed an automatic colorimetric instrument which can distinguish between 10-C oil and Pyranol and can prevent the wrong pump from being energized. Fortunately, the two liquids have a difference in color which allows for continuous monitoring and immediate detection of any inadvertent mixing.

In the laboratory we measured the light transmission characteristics of both liquids to find the wavelength at which the difference in transmission would be greatest. This was done by using a colorimeter to plot light transmitted against wavelength. We found that the maximum absorption for 10-C oil was at 390 mu, at which wavelength Pyranol shows only slight absorption. Thus, if a standard amount of light of this wavelength were passing through Pyranol and the flow suddenly changed to 10-C oil, the light transmission would

* Reg. G.E. trademark.

decrease considerably. This forms the basis for detection.

The instrument we use is an adaptation of the Bausch & Lomb Spectronic 20 colorimeter. Basically, this consists of a source of light; a means such as a prism or filter for selecting a certain wavelength; a sample cell; and a photoelectric cell for determining the amount of light passing through the sample. In adapting the laboratory-type instrument to continuous-flow measurement, the sample cell was replaced with a flow-through type.

In Fig. 1 we explain the setup, while Fig. 2 shows the actual installation of the two colorimeters. In the latter, the instruments appear one over the other, showing the bypass pipes from the main lines, with the top of the sample cells protruding from the instrument cases at the left, below the flow switches and small bypass pumps.

In the diagram we see a transformer being drained to either of two storage tanks. Liquid flowing through either line is bypassed through one of the colorimeters, one tuned to 10-C oil and the other to Pyranol. If the liquid is Pyranol, then the Pyranol meter energizes the pump P_2 to the Pyranol tank, while the 10-C oil meter is out of range for 10-C oil and de-energizes pump P_1 to the 10-C oil tank. Thus, even though the operator has inadvertantly set the valves incorrectly, the wrong pump will not operate and thus the liquid will not be directed to the wrong storage tank.

Let us see how this works: Each of the colorimeters receives a continuously flowing sample by means of a small pump P_c. Each is protected by a flow switch S which will shut down pumps P_1 and P_2 in case of no flow. The instrument for monitoring 10-C oil is set for 25% light transmission. Its meter M_1 is provided with high and low electrical contacts set at 15% and 35% transmission. If the liquid flowing is Pyranol, then transmission will increase and the upper contact will kick out relay R_1 and de-energize pump P_1. To make the instrument fail-safe, the lower contract will stop pump P_1 if transmission should drop below that of 10-C oil.

The meter for monitoring Pyranol is set for 100% light transmission, with a contact on meter M_2 at 100%. If 10-C oil should enter the sample system, transmission will drop greatly, relay R_2 will kick out and pump P_2 will be de-energized.

In testing the installation with known mixtures, we were able to detect the mixture immediately. But, since the system went into operation, there has been little recurrence of inadvertent mixing, probably because of a psychological effect of the new quality-control "watchdogs."

Curing Troubles With a Long Gage Glass

T. H. Anderson
Engineer, Oak Ridge, Tenn.

Dimensional changes plus vibration had been the bane of a 6-ft. long gage glass installed in the end of a 7-ft.-diameter, horizontal storage tank which protruded into a building from its buried position under a clay bank outside the wall. With constant breakage of the glass, it became evident that this extraordinary length was incapable of withstanding the imposed stresses.

The cure proved to be very simple: we simply provided an expansion joint at the midpoint in the form of 6 in. of clear plastic tubing cemented to the two half gage glasses which we substituted for the single long one. Another novel idea here was to put a strip of cardboard marked with alternate ½-in. black and white diagonal stripes behind the glass. This made the level much more readable even across the room.

"Music-Box" Roller Cleans Intake Screen

McGraw-Hill's Vienna news bureau has uncovered an interesting river-water intake screen developed at the RAMO refinery in Pardubice, Czechoslovakia, to overcome earlier clogging difficulties.

The screen itself is a vertical cylinder of heavy-gage perforated metal, with ⅛-in. holes precisely spaced at equal distances apart. A roller, looking like an old-fashioned music box roller, carries equally spaced steel pegs about ¼ in. in diameter. The roller is supported on an arm at the top, pivoted on the axis of the vertical perforated cylinder, and held in contact with the cylinder by the arm.

When the arm is rotated by an arrangement of shaft, sprockets and drive chain from above the surface, the roller moves around the cylinder in planetary fashion, with the pegs forcing their way through the cylinder holes and discharging any mud or other clogging material.

Next Issue: Steam Generator for Pilot Plant Work

By M. S. Schwartz, Winner of the January Contest

★ How Readers Can Win

$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Process Design Notebooks. Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Process Design Notebooks, *Chemical Engineering*, 330 W. 42 St., New York 36, N. Y.

PRACTICE . . .

YOU & YOUR JOB

EDITED BY R. F. FREMED

"The professional man contracts to use reasonable and ordinary care and diligence in the exertion of his skill."

You Must Deliver Competency and Skill

A complaint of "unsatisfactory engineering performance" has been the key issue in recent multimillion-dollar legal tangles. What limits the liability of engineers and their employers?

Albert Woodruff Gray, Attorney, Forest Hills, N. Y.

Competency and skill are demanded by the law of every engineer in the performance of his work.

However, except under the provisions of an unusual contract, the engineer guarantees neither satisfaction nor results. Instead, he is and has been for centuries responsible for the exercise of average professional knowledge and experience.

What is average engineering performance? Often our courts have been asked to help answer this question.

For example, in a suit now pending in the U. S. District Court, Trenton, N. J., plaintiff is asking for a judgment of more than $10,000,000 in damages against an engineering firm. The complaint charges that this firm, "in the manner of its supervision with respect to the project, has failed to exercise ordinary skill expected of engineers, was grossly negligent and failed to exercise due care under the cirstances."

Here the question that must be settled is not whether these engineers attained the results anticipated by their employer, but whether the ability and skill they exercised was the ability and skill of competent members of the engineering profession.

(Note also that the question

of professional registration and licensing is not involved in this case at all. In fact, many of the engineers involved in the project are chemical engineers who are not state-registered.)

▶**Some Precedents**—Perhaps a look at some legal precedents will help us understand the issues which must be decided.

An engineer in New York State, engaged in the construction of a plant for the production of potash, brought suit against his employer to collect unpaid salary. He was met with a counterclaim based on the charge that he had not "properly performed his duties as such consulting engineer."

In this instance the following principle of law was invoked: that an engineer's liability is measured by his skill and knowledge in his profession and not by the results he achieves.

This engineer had been employed to assume the entire responsibility for the design and construction of a chemical plant. Four months later he was discharged for failure to effect the results anticipated by the employer.

As balm for these disappointed hopes, financial damages were claimed by the employer.

▶**Use Best Endeavor**—In refusing to measure the liability of the engineer merely by the results of his work, the New York appellate court said, "It is not at all clear what the engineer meant in his letter, which entered into the contract wherein he stated that he assumed 'entire responsibility for the design and construction of their new works.' The process was a new one in an experimental stage.

"It would, I think, be a violent construction of this contract to hold that the engineer intended thereby to guarantee the sufficiency of the plant which was to be erected under his care.

"I think a fair interpretation of this contract would hold the engineer to an obligation to assume full charge of the construction of the work and to use best endeavor to accomplish this purpose."[1]

Application of this time-honored rule to a Virginia case highlights the freedom of an architect, engineer or any other professional worker from liability for the failure of the employer to receive perfect plans or flawless results. Details are given in Ref. 2.

▶**The Windmill Case**—Contrasted with these circumstances was an incident that occurred many years ago in Indiana.

An engineer undertook to install a 16-ft. windmill with a steel tower and frame, weighing approximately 1 ton, on the roof of a round barn 100 ft. in diameter, 34-ft. high to the eaves, with a conical roof rising to a height of 70 ft.

In a windstorm this mill collapsed onto the roof of the barn. The Indiana court held the engineer liable for the consequent damage. "In every situation where a man undertakes to pursue a particular course he is under implied legal obligation or duty to act with reasonable care, to the end that the person or property of others may not be injured by any force which he sets in operation.

"If he fails to exercise the degree of care the law requires in a particular situation, he is held liable for any damage that results to another, just as if he had bound himself by an obligatory promise to exercise the reasonable care required."[3]

▶**A Fundamental Rule**—This rule that an offer of engineering or other professional services carries with it an implied warranty that the services will be performed with care and skill, is a basic principle of law in any contract for services.

When an experienced driller in California sued for the amount due him under a contract for drilling a well, the owner of the land set up the following defense: poor workmanship on the part of the driller.

In sustaining a verdict in favor of the driller the court set out two essential points:

"Accompanying every contract is a common law duty to perform with care, skill, reasonable experience and faithfulness the thing agreed to be done and a negligent failure to observe any of these conditions is a wrong, as well as breach of contract.

"The rule which imposes this duty is of universal application as to all persons who by contract undertake professional or other business engagements requiring the exercise of care, skill and knowledge. The obligation is implied by law and need not be stated in the agreement."[4]

In a contract for the installation of concrete piles for the support of a proposed building in Illinois, the preparation of the piles as well as the method of their installation was agreed upon with no stipulations other than that the work be "accomplished to completion as speedily as is consistent with good workmanship."

When it became apparent that the supports were inadequate for their purpose, suit was brought by the owner. Defense to the suit was this: There could be no warranty of workmanship since the work was done under precise specifications and these provisions negated any implied warranty.

The court sustained the owner in his refusal to pay for the work including this comment:

"It was part of this contract that this company would do this work with reasonably good materials in a reasonably workmanlike manner and in such a way as to reasonably meet such requirements as it had notice the work was required to meet.

"All persons impliedly undertake, when they engage to do work, that they have a reasonable amount of skill in the employment and that they will use it, and also engage for a reasonable amount of care."

To this statement the court added a quotation from an earlier decision by an Illinois court, "It is one of the plainest principles of law that there is an implied warranty or undertaking in all cases that a person so acting is reasonably skillful in his profession, trade or calling. And that he will perform his engagements in his calling with that degree of skill."[5]

▶**Which Yardstick?** — Duties owed by an engineer to his employer are essentially the same as those assumed by an architect or any other professional worker.

Also, the law governing the liability of the engineer for neg-

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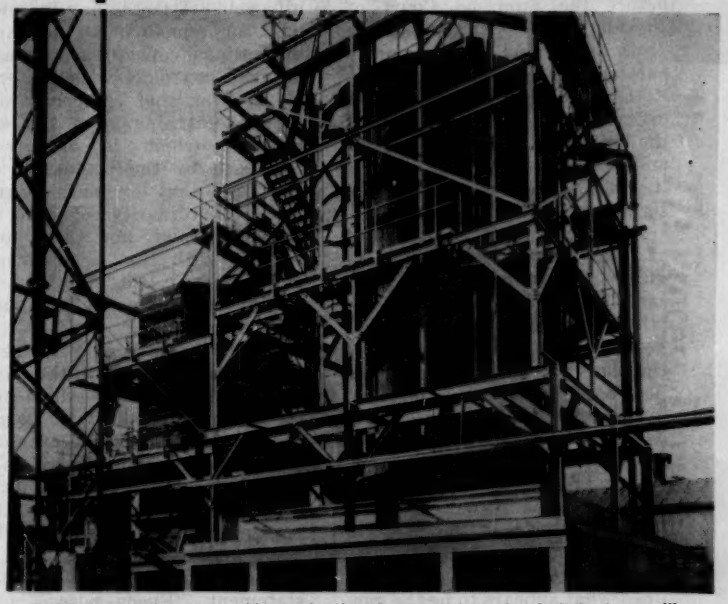
Manager, Process Equipment Sales

J. F. Revilock

Mr. Revilock was graduated from Case Institute of Technology with a B.S. in Chemical Engineering. For two years he worked at a mid-west research center, designing and installing chemical process equipment for pilot plant production of special aircraft fuels and lubricants.

Mr. Revilock joined National Carbon Company in 1944. For three years he worked in the Sales Department Development Laboratory designing and testing new "Karbate" impervious graphite products and improving existing equipment. For the past eleven years, he has been actively engaged in the design, construction, installation and process application of carbon, graphite and "Karbate" impervious graphite equipment. In 1954, he was appointed Manager of Process Equipment Sales, Chemical Products Marketing.

NATIONAL CARBON Makes the World's Largest Diameter Graphite Combustion Chamber



World's largest diameter graphite combustion chamber and a carbon hydrator tower will produce phosphoric acid from elemental phosphorus for The American Agricultural Chemical Company at their Carteret, New Jersey plant.

The graphite combustion chamber shown above – the largest in diameter ever installed–is being built with precisely machined graphite parts from National Carbon Company. It is 37'-3" high with an inside diameter of 20'-4". Phosphorus burned with air within the chamber is subsequently hydrated in the carbon tower shown at the left to produce phosphoric acid. This carbon hydrator is also the largest NATIONAL CARBON has ever built.

NATIONAL CARBON's graphite and carbon materials are well suited to this application because they provide corrosion-resistance and structural stability at elevated temperatures combined with ready machineability and moderate costs.

NATIONAL CARBON Has Facilities for Precise Machining of Large Structures

Photos show close tolerance machining of a wall block and factory preassembly of a block type graphite vessel for high temperature chlorination. Machining was done on new moving-bed horizontal milling equipment to tolerances of ± .010". The entire unit was pre-assembled in the plant with .010" thick shims to simulate cement joints to be made in the final installation. Men with years of experience in machining carbon and graphite working with modern equipment make this close tolerance work possible.

Working closely with NATIONAL CARBON's production staff are sales and technical service engineers with the industry's most extensive know-how in the design of carbon and graphite equipment for high temperature service. This combination of process knowledge and production experience makes National Carbon Company the leading supplier of graphite and carbon products used in the chemical process industries.

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ligent performance is equally applicable to the negligence in architectural work. Ref. 6 discusses this similarity.

Controversy over the yardstick to be used in the computation of damages and the extent of liability of engineers either for negligence or a breach of contract of this character came before the Supreme Court of Florida. The court quoted this "safe and sound" rule from an outstanding legal authority:

"It is an amount equal to the difference between the value of the building as actually designed and constructed and the value as it would have been properly designed and constructed."

Standards for the estimation of damages incurred through engineering negligence recently came before a court in the District of Columbia. There engineers had undertaken to prepare the plans and specifications for a heating system to be installed under their supervision which would maintain a temperature of 70 F.

After the plans had been completed and the system installed, it was found that the building was inadequately heated.

In its decision the court outlined what appears to be the generally accepted rule in the computation of damages of this character.

"Compensation is the basic principle of damages," said the court. "For breach of contract the injured party is entitled to be compensated for losses which are the natural consequence and proximate result of the breach. The purpose of such compensation is to place the injured party in as good a position as that in which full performance would have placed him.

"He is not entitled, because of a breach, to be put in a better position than he would have had the contract been fully performed."

The court concluded, "It is true that the architects' error caused the owner to believe and expect that he could construct the plant at a lesser price than it actually cost. But . . . the law does not provide compensation for disappointment over nonrealization of a belief or expectation.'"

▶**1853 New Hampshire**—This universal rule that limits the liability of an engineer for negligence to the exercise of only reasonable care, rests on a decision by the Supreme Court of New Hampshire, rendered in the middle years of the last century.

"By our law a person who offers his services to the community generally or to any individual for employment in any professional capacity as a person of skill, contracts with his employer first, that reasonable degree of learning, skill and experience which is ordinarily possessed by the professors of the same art or science and which is ordinarily regarded by the community, and those conversant with that employment, as necessary and sufficient to qualify him to engage in such business.

"In all these cases . . . skill means ordinary skill in the business or employment which the employee undertakes. He is not presumed (to possess) extraordinary skill, which belongs to a few men only. Reasonable skill constitutes the measure of the engagement in regard to the thing undertaken."

The Court added a further statement, "Every person who enters a learned profession undertakes to bring to the exercise of it a reasonable degree of care and skill. He does not undertake, if he is an attorney, that he will at all events gain your case, nor does a surgeon undertake that he will perform a cure, nor does he undertake to use the highest possible degree of skill.

"There may be persons who have higher education and greater advantages than he has, but he undertakes to bring a reasonable, fair and competent degree of skill.

"In the second place, the professional man contracts that he will use reasonable and ordinary care and diligence in the exertion of his skill and the application of his knowledge, to accomplish the purpose for which he is employed. He does not undertake for extraordinary care or extraordinary diligence any more than he does for uncommon skill.

"This general rule is well settled, as in other cases of contracts supposed to be mutually beneficial to the parties, that the contractor for services to be performed for another agrees to exercise such care and diligence in his employment as men of common care and common prudence usually exercise in their own business of a similar kind.

"He agrees to be responsible for the want of such care and attention and he stipulates in no event, without an express contract for that purpose, for any greater liability.'"

▶**What Is the Limit?**—What, then, is the limit of liability that may be imposed on an engineer or his employer?

It all seems to boil down to this. Should you be involved in a situation in which your performance as an engineer is questioned, the courts will turn to your peers and ask them to decide whether you have rendered reasonable service, ordinary diligence and common skill as demonstrated by other persons who call themselves engineers.

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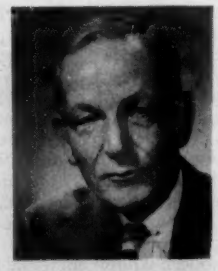


ALBERT WOODRUFF GRAY was born in Middletown Springs, Vt., and attended Yale Univ. and New York Law School. He has been engaged in the independent practice of law for more than 20 years. Gray is the author of Conover-Mast's "Purchase Law Manual," and *CE*'s articles "How Our Laws Protect Engineering Ideas" (Mar. 9, 1959) and "Why Engineering License Laws?" (July 13, 1959).

No. 27: Process Equipment Nomograph

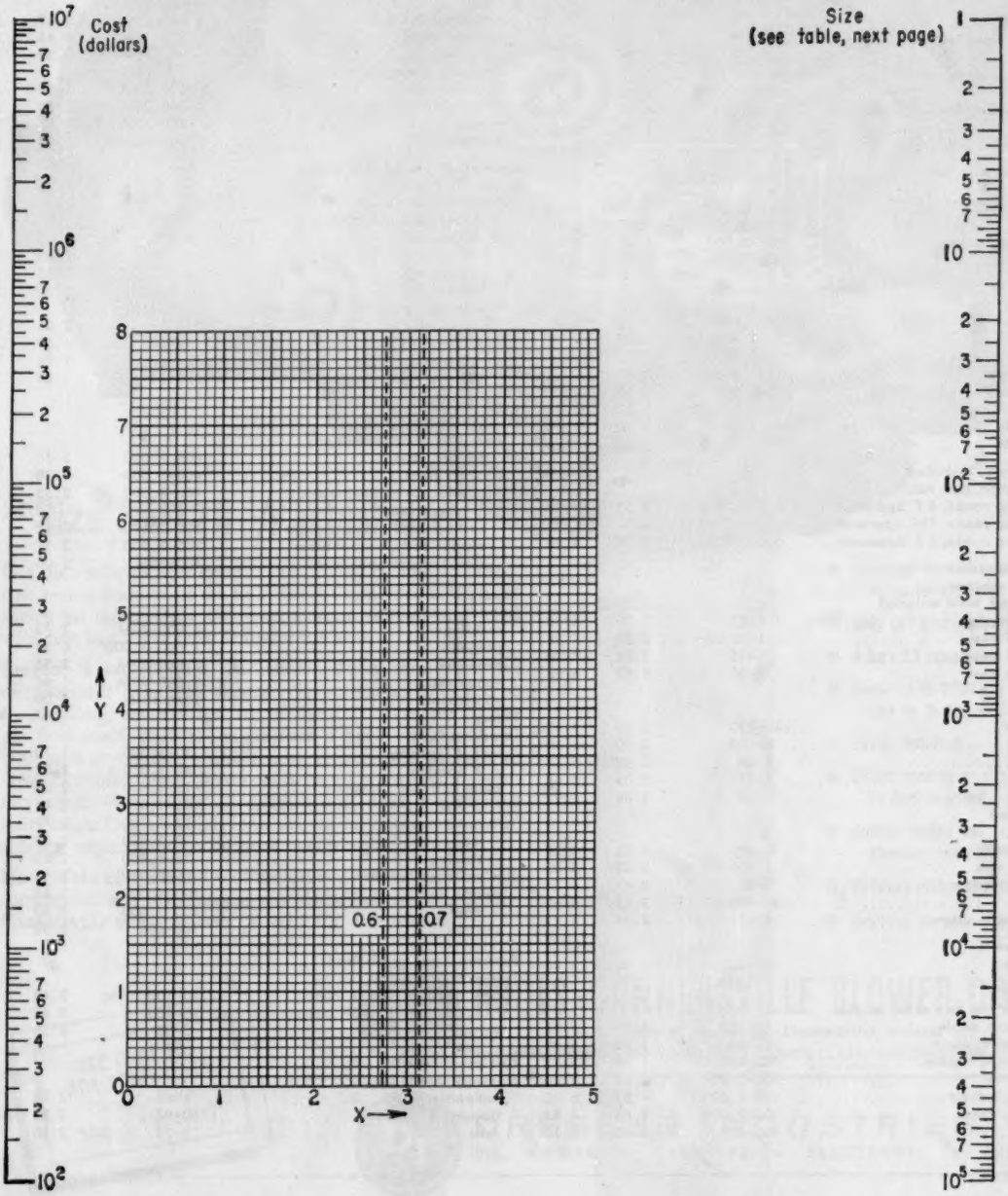
S. M. Walas, University of Kansas, and C. D. Spangler, C. W. Nofsinger Co.

Nomograph Updates Process Equipment Costs

Data on costs of equipment used in process plants are widely scattered, so for convenience, we made this chart to gather and compress it. Most equipment needed in the process industries is represented; for other equipment whose cost is known to vary as the 0.6 or 0.7 power of size or capacity, the chart permits cost prediction if a single size-cost relation is available.

To use the chart, find—in the table on the next page—coordinates for the appropriate equipment. These coordinates establish a pivot point in the grid below; any line passing through this point intersects size and cost axes in corresponding values. Items whose costs vary as the 0.6 or 0.7 power of size or capacity have pivot points on the vertical lines so marked.

Data are purchased costs, except the cooling towers which are installed. Several published and private sources were used, but much are from Aries & Newton, "Chemical Engineering Cost Estimation," McGraw-Hill, New York (1955) and Nelson, "Costimating," *Oil & Gas Journal*, Tulsa (1957). Costs were updated by the Marshall & Stevens Index: June '59 = 234.3.



Equipment Cost Coordinates

Item & (Units)	Range	Coordinates x	Coordinates y
Barometric condensers			
(water rate, gal./min.)			
steel	200–5,000	3.21	3.13
cast iron	40–5,000	2.80	3.28
rubber-lined steel	200–3,000	2.36	3.33
Blowers			
(cu. ft./min.)			
centrifugal turbo, 0.5–2.0 psi	100–10M	2.78	2.72
7–10 psi	1,000–40M	2.82	3.63
20–30 psi	4,000–30M	2.75	4.28
rotary, 10–15 psi	100–3,000	3.73	3.45
Centrifuges			
(diameter, in.)			
batch, top-suspended, steel	20–40	4.40	5.55
stainless	20–40	4.55	5.90
batch, bottom-driven, steel	20–40	3.10	4.72
stainless	20–40	4.25	5.53
batch, automatic, Baker-Perkins, steel	19–80	4.10	6.10
stainless	18–80	4.20	6.28
Sharples Super D-Hydrator	20–25	4.10	6.50
Compressors, with driver			
(driver h.p.)			
centrifugal, motor	200–3,000	3.09	5.42
turbine	200–3,000	2.80	5.40
reciprocating, gas engine	200–3,000	3.53	5.45
motor	200–3,000	3.38	5.23
Conveyors			
(length, ft.)			
belt, enclosed, 18" width	10–1,000	3.30	5.07
24" width	10–1,000	3.37	5.13
30" width	10–1,000	3.50	5.26
36" width	10–1,000	3.57	5.34
belt, open, 18" width	10–1,000	3.30	4.70
24" width	10–1,000	3.30	4.79
30" width	10–1,000	3.30	4.90
36" width	10–1,000	3.30	4.98
Cooling towers, installed			
(water circulation, gal./min.)			
25 F. cooling range, 5 F. approach	5,000–70M	3.50	4.40
25 F. cooling range, 10F. approach	5,000–70M	3.50	4.20
15 F. cooling range, 5 F. approach	5,000–70M	4.28	4.28
Crushers & grinders			
ball mills, reduction			
(ton/hr., med. hard material)			
¾"–48 mesh	1.5–25	2.90	6.80
¼"–325 mesh	1–10	2.87	7.38
½"–100 mesh	1–15	2.95	7.10
1½"–10 mesh	3–50	2.87	6.38
crushers			
(driver h.p.)			
gyratory	30–220	2.90	5.52
jaw	3–100	2.60	5.10
rolls	5–60	2.68	5.35
rotary	2–27	3.05	4.82
sawtooth	5–40	3.08	4.92
mills & cutters			
(driver h.p.)			
attrition mills	5–300	2.92	4.57
hammer mills	4–400	3.48	5.03
Mikro-Pulverizer	6–30	2.94	5.54
roller	30–400	2.85	5.63
rotary knife cutters	4–80	3.55	5.22
Dowtherm units			
(1,000 Btu./hr.)	200–2,000	1.50	4.46
Dryers			
(peripheral or top tray area, sq. ft.)			
drum, vacuum, single	10–100	3.10	5.95
atmospheric, single	10–60	1.96	4.99
atmospheric, double	100–400	1.78	5.05
rotary, hot air	100–2,000	3.65	4.70
flue gas, indirect	100–1,600	4.03	5.02
flue gas, direct	100–2,000	3.83	4.85
vacuum	100–500	2.60	5.10
Dryers (cont.)			
tray, atmospheric, steel	30–200	2.00	3.57
atmospheric, stainless	30–200	1.97	4.07
vacuum, steel	40–200	2.58	4.13
vacuum, stainless	40–200	2.30	4.85
spray			
(capacity, lb./hr.)			
10 ft. diameter	800–3,000	1.50	5.10
14 ft. diameter	1,200–6,000	0.25	5.73
18 ft. diameter	2,300–9,000	0.20	5.95
Dust collectors			
(capacity, cu. ft./min.)			
centrifugal precipitators	600–20M	3.49	2.42
cyclones, single	900–20M	3.43	1.47
multiple	900–20M	3.39	1.68
electrostatic precipitators			
low voltage	600–20M	4.00	2.90
high voltage	7,000–20M	3.50	3.30
filters, automatic cloth	600–20M	3.87	2.45
washers	600–20M	3.85	2.28
Ejectors, steam jet, 100 psig. steam, 70 F. air			
(capacity, lb./hr. of air)			
single stage, noncondensing			
50 mm. Hg	10–60	2.50	3.38
76 mm. Hg	11–200	2.53	2.82
102 mm. Hg	20–300	2.35	2.72
152 mm. Hg	30–500	2.30	2.53
two-stage, barometric intercondenser,			
10 mm Hg	15–60	2.00	3.80
25 mm. Hg	16–100	1.53	3.32
50 mm. Hg	20–100	1.90	3.35
100 mm. Hg	20–120	1.80	3.22
Evaporators			
(heating surface, sq. ft.)			
forced circulation, iron body			
copper tubes	600–8,000	3.30	5.00
nickel tubes	400–7,000	3.70	5.20
horizontal, Cu or steel tubes	100–8,000	2.55	4.60
long tube vertical			
cast iron body, copper tubes	300–20M	3.37	4.55
copper body, copper tubes	200–3,000	2.97	4.98
steel body, copper tubes	400–50M	3.00	4.32
Fans			
(capacity, cu. ft./min.)			
centrifugal	4,000–70M	3.75	1.30
propeller	1,000–3,000	0.55	0.00
propeller	3,000–20M	3.55	0.95
vane-axial	2,000–20M	0.60	1.00
vane-axial	20M–40M	3.00	0.92
Filters			
(area, sq. ft.)			
leaf, 4" spacing	40–1,000	2.70	4.53
2" spacing	40–1,000	2.82	4.42
plate & frame, aluminum	15–1,400	2.86	4.20
bronze	15–1,400	2.85	4.60
cast iron	15–1,700	2.79	3.85
lead	15–1,400	2.83	4.40
stainless	15–1,400	2.80	5.02
wood, yellow pine	15–2,000	2.62	3.81
rotary, disk	100–1,000	3.65	5.10
drum	200–1,000	2.80	5.05
sewage	100–600	2.50	4.85
Furnaces, gas or oil fired			
(million Btu./hr.)			
box, 300 psig., 800 F. outlet	10–100	3.48	6.82
1,000 psig., 1,000 F. outlet	10–100	3.45	6.94
vertical	5–50	3.50	6.70
Gas producers			
(capacity, million Btu./hr.)			
anthracite	1–40	2.38	5.93
bituminous	20–90	0.85	5.54
coke	1–25	2.30	6.03

Continues on p. 176

THE *NEW* ROOTS 3000 cfh GAS METER IS "JUST A BULGE IN THE LINE!"

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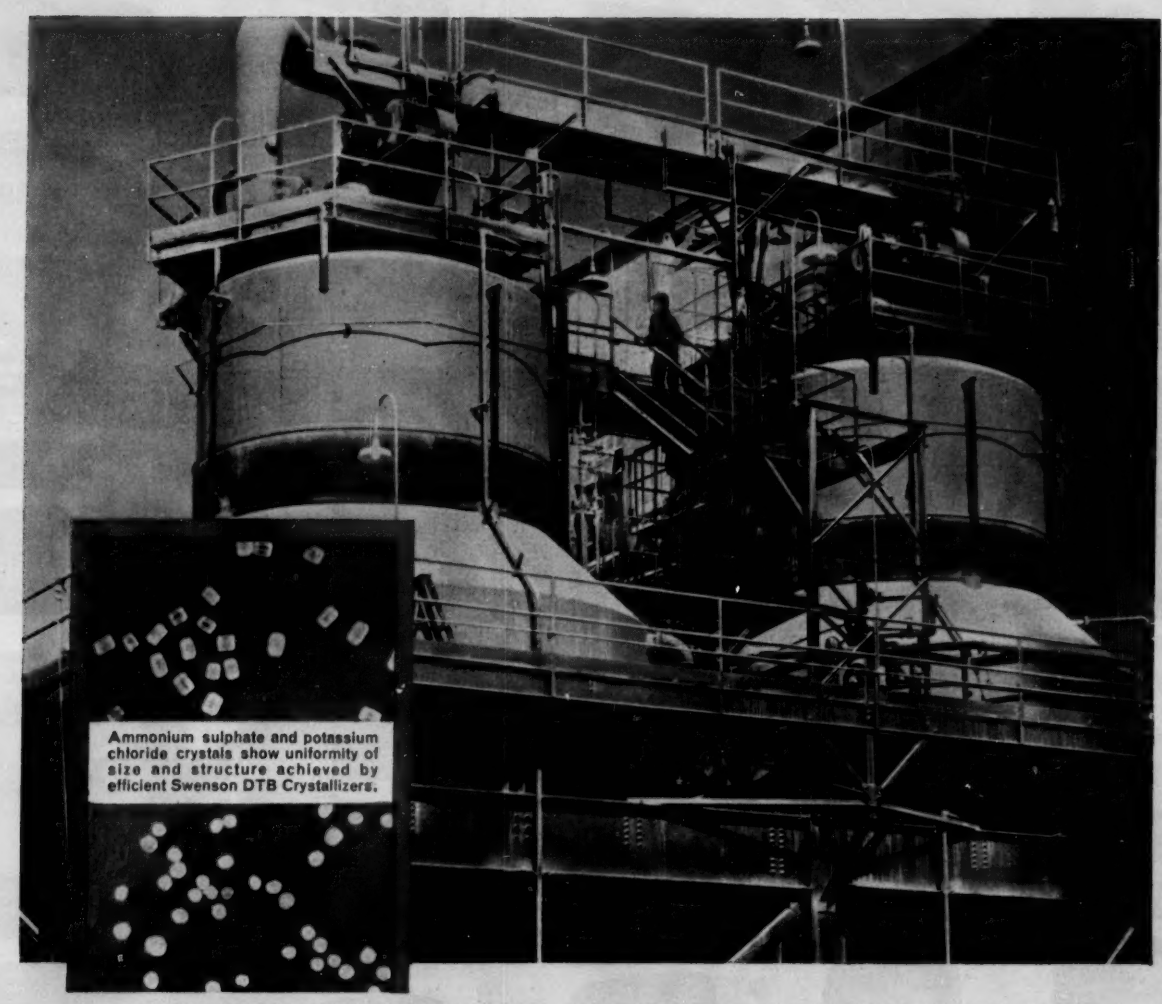
Equipment Cost Coordinates (continued)

Item & (Units)	Range	Coordinates x	Coordinates y
Ion exchangers			
(volume, cu. ft.)			
anion	70–400	3.25	5.20
hydrogen cycle cation	70–400	2.88	4.95
sodium cycle cation	70–400	3.60	4.50
Mixers			
(capacity, cu. ft.)			
pan mixer	4–40	3.37	5.02
ribbon blender	20–350	1.90	4.40
rotary blender	20–200	2.00	4.20
sigma mixer	1–20	2.50	6.20
(driver h.p.)			
propeller, fixed	5–50	2.82	4.70
portable	1–8	2.00	3.90
Motors, a.c., 220–440 v., 3-phase, 60 c., 3,500 rpm., with starters			
(horsepower)			
drip-proof	5–100	3.35	3.85
totally enclosed, fan-cooled	5–100	3.45	4.15
Pumps, with motor drivers & starters			
(driver h.p.)			
centrifugal, under 250 F.			
all iron	2–100	2.10	4.17
steel case, iron trim & impeller	2–100	2.02	4.25
steel, case, 12 chrome trim, iron impeller	2–100	2.02	4.30
centrifugal, over 250 F., steel case			
iron trim & impeller	2–100	1.85	4.54
12 chrome trim, iron impeller	2–100	1.85	4.56
12 chrome trim & impeller	2–100	1.90	4.60
reciprocating			
simplex, steam drive	3–10	1.60	3.85
duplex, steam drive	2–100	2.55	4.75
triplex or plunger, motor drive	2–100	2.80	5.38
(capacity, cu. ft./min.)			
vacuum, mechanical	30–700	2.00	3.85
Reactors, jacketed & agitated tank			
(capacity, gal.)			
glass-lined steel, 50 psig	50–2,000	2.50	4.10
stainless, 50 psig	50–2,000	2.30	4.13
300 psig	70–1,000	2.50	4.40
1,500 psig	70–400	2.35	5.82
steel, 50 psig	50–2,000	2.35	3.78
300 psig	70–1,000	2.45	4.00
1,500 psig	70–400	2.35	5.28
Storage tanks			
(capacity, gal.)			
agitated, steel	100–30M	2.15	3.25
stainless	100–30M	2.28	3.70
cylindrical, steel, 50–150 psig	400–100M	1.85	3.80
spheres, steel, 25 psig.*	10M–200M	2.85	3.82
50 psig.*	10M–200M	2.70	4.00
100 psig.*	10M–200M	2.53	4.33
spheroids, steel, 15 psig.*	60M–800M	3.30	3.45
(capacity, cu. ft.)			
gas holders*	1,000–1,000M	2.85	4.43
(capacity, bbl.)			
hydrocarbon, atmospheric*			
cone roof	10M–50M	2.00	4.60
	50M–150M	4.05	3.90
floating roof	10M–50M	2.00	4.75
	50M–150M	4.05	4.02
Thickeners, continuous			
(settling area, sq. ft.)	200–1,000	2.60	4.08

Item & (Units)	Range	Coordinates x	Coordinates y
Towers, fractionating, 20–50 trays, steel (cost, $/tray)			
(square of dia., sq. ft.)			
¼" shell	9–49	1.00	3.50
	49–144	3.10	4.45
½" shell	9–49	1.40	3.80
	49–196	3.20	4.60
¾" shell	9–49	1.25	3.80
	49–196	3.05	4.60
Vessels			
(weight, 1,000 lb.)			
steel	1–50	3.35	5.62
0.5 Cr, 0.5 Ni	1–50	3.35	5.90
18–8 Cr Ni	1–50	3.35	6.45
above 50,000 lb., cost ($/lb.) remains constant			
Heat exchangers			
(tube surface, sq. ft.)			
floating head			
all steel, ¾", 1" sq. pitch, 16 ft., 150 psig	100–4,000	3.00	3.55
300 psig	100–4,000	3.00	3.60
steel shell, brass tubes, 150 psig	100–4,000	3.30	3.80
300 psig	100–4,000	3.30	3.90
steel shell, 5 chrome tubes, 150 psig	100–4,000	2.50	3.93
600 psig	100–4,000	3.60	4.20
fixed tube sheet, all steel, ¾", 15/16" triangular pitch, 16 ft., 150 psig	100–4,000	2.95	3.34
U-tube, all steel, ¾", 15/16" triangular pitch, 16 ft., 150 psig	100–4,000	3.00	3.41
Screens, vibrating			
(area, sq. ft.)			
single-deck	10–30	2.25	4.15
double-deck	10–30	1.95	4.10
triple-deck	10–30	2.10	4.25
Petroleum processing units			
(product capacity, bbl./day)			
alkylation	500–1,800	2.75	7.13
	1,800–9,000	3.50	7.09
aromatics recovery†	1,000–10M	3.80	6.04
lubricating oil manufacture†	1,500–12M	3.70	6.60
polymerization, catalytic	400–1,400	3.25	6.80
	1,400–9,000	3.81	6.79
(charge capacity, bbl./day)			
coking, delayed or fluid	1,250–30M	3.30	6.50
cracking, catalytic (includes feed preparation, gas recovery and polymerization unit)†	3,000–30M	3.60	5.25
cracking, thermal	1,700–20M	3.10	6.55
desulfurization of gasoline, catalytic	900–15M	3.66	5.62
distillation, atmospheric	1,000–100M	3.10	5.75
distillation, vacuum	2,000–25M	3.50	5.37
distillation of lubes, vacuum	500–15M	3.30	6.05
reforming, platinum catalytic	1,500–25M	3.90	6.13
solvent extraction or deasphalting	700–20M	3.25	6.68
solvent dewaxing	700–5,000	3.45	6.93
The following are combined petroleum processing units:			
topping & asphalt manufacture	3,000–20M	3.10	6.90
topping, thermal cracking, catalytic reforming and polymerization†	4,000–50M	3.70	5.25
topping, catalytic cracking, catalytic reforming and polymerization†	7,000–100M	3.53	5.60
Complete, for all products**	12M–100M	3.95	4.32

Note: Petroleum processing plant costs are updated from the original references in Nelson "Petroleum Refining Engineering," 4th ed., p. 878, McGraw-Hill, New York (1958) by use of the Nelson construction index: July '59 = 223.5

* Divide capacity by 10 before entering chart. † Multiply cost by 10. ** Multiply cost by 100.



Ammonium sulphate and potassium chloride crystals show uniformity of size and structure achieved by efficient Swenson DTB Crystallizers.

23 FOOT DIAMETER DTB CRYSTALLIZERS

PRODUCE BETTER SALTS

Potassium chloride production is in high gear at American Potash and Chemical Corporation of Trona, California. Their two new Swenson DTB Crystallizers (draft-tube, baffle-type), the largest ever built, produce potassium chloride from concentrated brine at a remarkably high production rate. The new equipment produces large, uniform crystals of premium value—does it with low wall salting, and long operating cycles, because of its simplified basic design. Versatile DTB Crystallizers are readily adaptable to the production of many different salts. Their demonstrated performance in terms of crystal size and uniformity is convincing manufacturers everywhere to turn to DTB Crystallizers. Call Swenson—leader in the field—for details.

FREE BOOKLET . . . Tour the nation's leading processing plants serviced by Whiting/Swenson equipment for cost-cutting ideas! Write for "Processing Profiles" today! *Swenson Evaporator Company, 15669 Lathrop Avenue, Harvey, Illinois*

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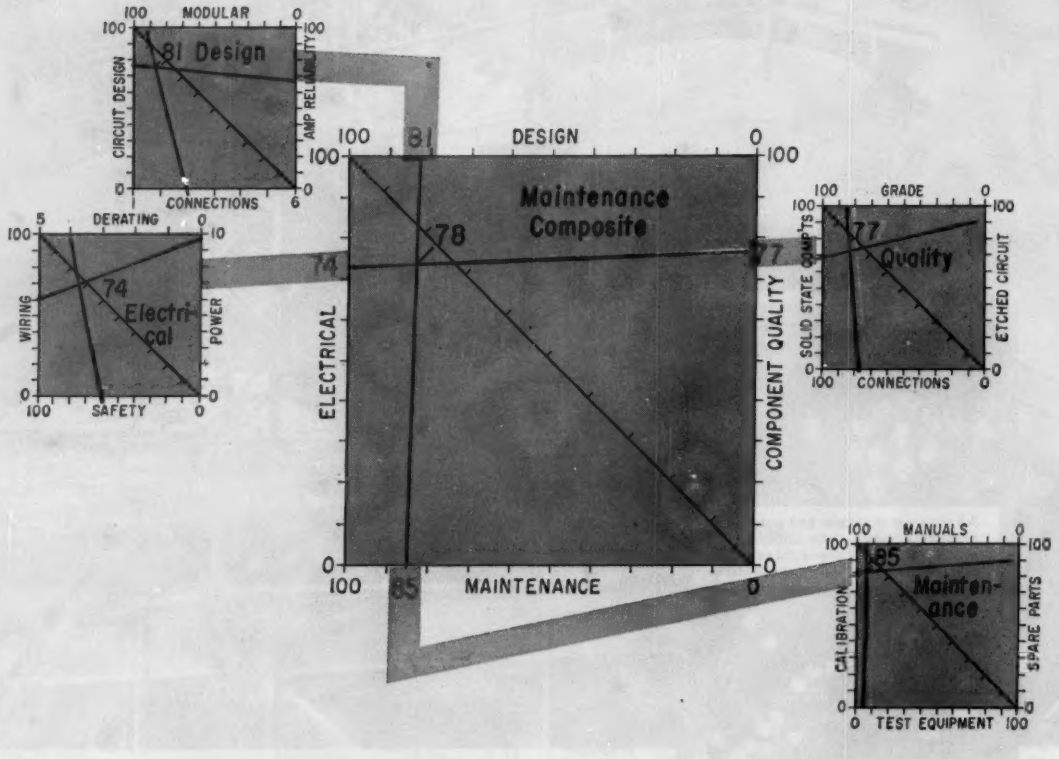


Rate Instruments for Maintenance

Proper evaluation can help reduce the instrument portion of rising plant-maintenance costs.

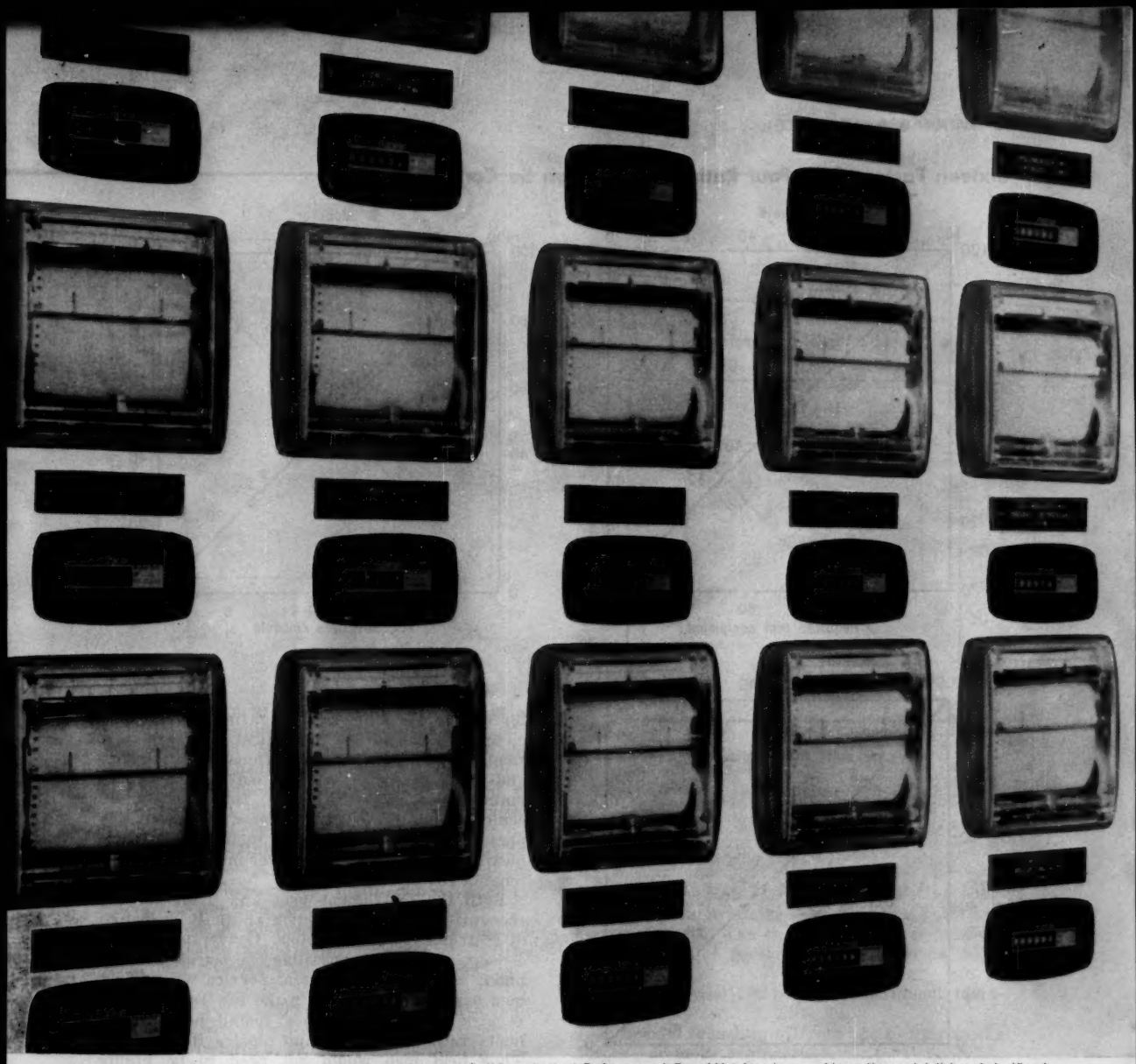
A. T. SHERMAN, Consultant Supervisor, Engineering Service Div., Du Pont Co., Wilmington, Del.

Increased chemical plant instrumentation will cause a significant and rapid increase in maintenance costs.

For several reasons, instrument maintenance costs appear to be increasing at a greater rate than instrument investment which, in turn, is an ever increasing part of total plant investment. A major reason for these increased costs is the use of new equipment such as scanner-loggers, analyzers, computers and other new types of electronic hardware for which previous maintenance experience is limited. This situation requires a plant to carry more spare parts and extra equipment, increase maintenance facilities, increase manpower, and generally improve technology.

Each of these items is important, but especially important is the spare-parts situation when an expensive one-of-a-kind instrument is purchased. Often the spare-parts investment for one piece of equipment is as great as that for five or ten identical units. The investment for one unit then becomes 15 to 30% of the purchase price rather than less than 5% for several units.

Existing calibration equipment and mainte-



On this centralized Foxboro panel, Type 14A Integrators provide continuous totalizing of significant process and plant service flows – recorders give trend records required by operating personnel.

Simplest way to get continuous, accurate totalizing

of all process and plant service flows

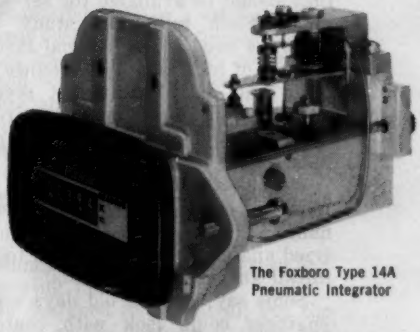
For automatic flow-accounting of all process and plant service fluids, Foxboro Type 14A Pneumatic Integrators offer unparalleled advantages of accuracy, convenience, and economy.

Easily connected to signal lines from new or existing Foxboro d/p Cell* Flow Transmitters, 14A Integrators provide **continuous** totalizing of significant flows. They can be mounted with the d/p Cell at the point of measurement, or panel-mounted hundreds of feet away.

The square root function is automatically extracted — flow totals are read directly. A simple, inherently accurate, centrifugal force system eliminates the errors of cams, special chambers, linkages, and intermittent counting.

Bulletin 13-23 fully illustrates and describes the Type 14A Pneumatic Integrator, and points the way to economical accounting of process and plant service flows. Write for your copy today. **The Foxboro Company, 363 Neponset Ave., Foxboro, Mass.**

*Reg. U.S. Pat. Off.



The Foxboro Type 14A Pneumatic Integrator

FOXBORO

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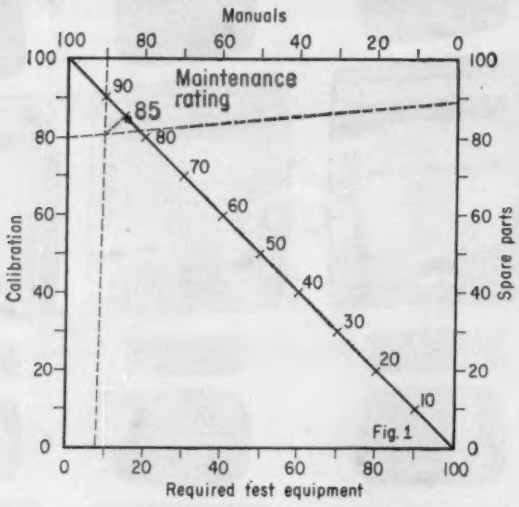
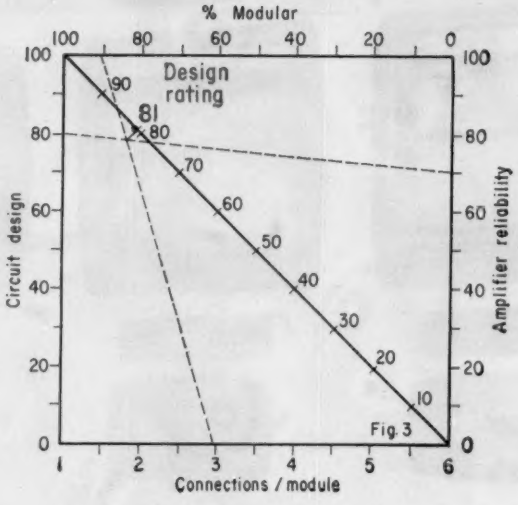
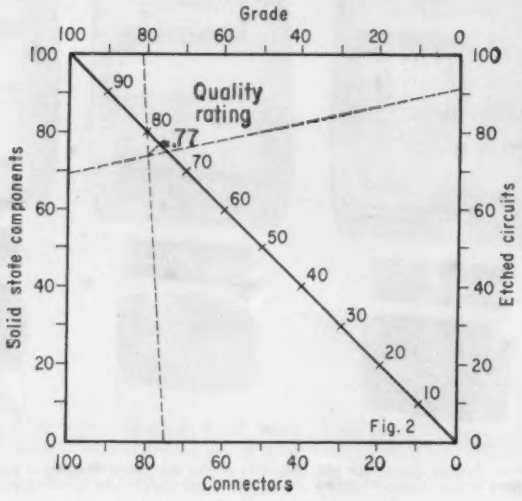
Sixteen Factors Give Four Ratings Which Can Be Correlated







nance facilities must be equated against those that should be available for servicing new equipment. Such individual study will frequently show the need for additional investment.

Costs of increased maintenance facilities, spare parts and extra equipment seem to be fixed. Therefore, the investment required for each new type of equipment is difficult to reduce or eliminate.

We believe that the increased manpower and improved technology requirements for maintenance of complex instrumentation can be analyzed and effective steps taken to reduce both the initial and continuing costs.

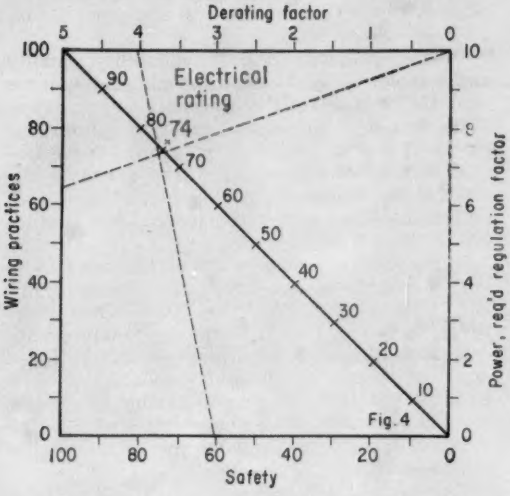
Some say that the old days are gone when an engineer could look with contentment at his completed project with its many arrangements for wheels wheeling, lights lighting, and motors motoring. The future theoretical ideal will be a small box that meets all functional requirements and has nothing in it. The old days provided maintenance problems. The future ideal, if achieved, has few such problems. However, the present trend is to increased quantity and complexity of instruments with ever increasing maintenance requirements.

Both the instrument user and manufacturer recognize the need for quick and easy exchange of instrument subassemblies. Conversion to this concept would make possible the so-called "telephone company" instrument service where field men carry few tools and make few tests. When repairs are required, they install new components rather than attempt repairs in the field. Thus field men would not need to be highly trained, skilled technicians because the removed part would not be repaired in the field. It would be given a thorough shop overhaul by skilled mechanics equipped with adequate test instruments. This system would minimize disturbances to plant operations.

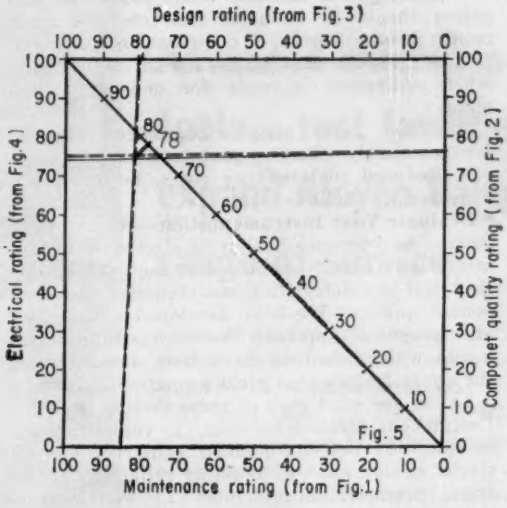
Unfortunately, it seems reasonably clear that we cannot reach this goal of plant maintenance for some time because:

- Plant instrument maintenance is greatly affected by the design of the instruments already installed.
- Existing plant personnel must do the required maintenance. To help reduce maintenance costs, then, we must design our instruments to fit our maintenance concepts. These concepts might include three levels of maintenance and maintenance accomplishment as follows:

▶ **First-Level Maintenance**—This would include scheduled and nonscheduled visual inspections, adjustments and minor replacements which would be accomplished from the front of the board with-



Composite Index of Maintenance Design



out interruption of service. There might be brief shutdown for minor replacements.

▶**Second-Level Maintenance**—This is scheduled and nonscheduled performance testing, calibration and checking without interruption of service. Again, all work would be done from the front of the board.

▶**Third-Level Maintenance**—This would be repairs when necessary with removal of assemblies to the shop for complete maintenance. Factory service would also be used as required.

Rejection of equipment not designed around these concepts would bring pressure on instrument manufacturers to design for easy maintenance.

Plants have purchased equipment primarily because it would perform a prescribed function —initial purchase price was the determining factor, installation and maintenance costs seldom played an important role. However, maintenance costs should be a major consideration in purchasing because they continue as long as the item is in service. Good engineering requires proper weighing of all major factors that contribute to costs.

▶**What Determines Instrument Costs?**—Both the manufacturer and the plant determine instrument maintenance costs. The manufacturer influences these costs to the degree that he considers maintenance when designing the instrument. Having bought the instrument, the plant further influences costs in the educational prerequisites of maintenance personnel, the degree of maintenance know-how, and the quantity of test and calibration equipment needed. Spare-parts requirements, which also influence costs, are the responsibility of both the plant and the manufacturer.

You can design instruments requiring much maintenance know-how and test equipment and high educational levels. Or you can design them with an eye to available shop facilities, parts and test equipment. The existing level of technology and numbers of personnel should also be taken into account.

Items contributing to high instrument maintenance costs are:

1. Special schooling of from two to four weeks for one or more engineers.
2. Component failures during start-up, often necessitating instrument redesign.
3. Maintenance manuals arriving as much as a year after delivery of the equipment. These manuals often lack important information and are frequently poorly written.
4. Special education for mechanics.
5. Contract maintenance from a distant point, which is sometimes costly and time consuming.
6. Maintenance know-how becomes so special that very few and sometimes only one mechanic can develop competence.
7. Maintenance is not given design consideration. Maintenance design considerations are often late and of limited scope.

▶**Better Design Will Help**—Improvements through better design for maintenance can reduce maintenance.

Potential accomplishments of better design and maintenance planning include:

1. Instruments designed to permit all but the most major service to be performed from the

front so that equipment can be serviced in place.

2. Major component parts and assemblies designed for easy accessibility and replacement.

3. Small parts and small subassemblies should be readily replaceable so that it will not be necessary to replace larger, more costly assemblies.

4. Use of a minimum number of standard size screws, nuts, and bolts.

5. Maintenance manuals, spare parts lists and prices should be available not later than one month prior to arrival of equipment at the plant.

6. All replacement parts should be on hand when equipment is ready for delivery at the plant.

7. Better, safer, simpler equipment designed for reasonably effective maintenance.

8. Reduced maintenance costs, better equipment service and life.

▶ **Evaluate Your Instrumentation**—We can summarize maintenance design of electronic instrumentation from four principal factors—design, electrical characteristics, maintenance and component quality. We have developed a narrative and graphical approach for evaluating instruments which involves check lists derived from the above factors that yield a composite index.

Let us see what each of these factors involves. Design consideration includes (1) connectors per module, (2) percent modular construction, (3) circuit design and (4) amplifier reliability. Electrical characteristics include (1) wiring practices, (2) safety, (3) derating factor and (4) power and regulation requirements. Component quality considerations are (1) connectors, (2) solid state components, (3) grade of components and (4) etched-circuit construction. Maintenance includes (1) required test equipment, (2) spare parts, (3) calibration and (4) manuals.

We developed a scale for each of these 16 subfactors, examined each one, determined a number value and plotted it to arrive at an index. With these subindexes, we obtained an index for each of the four main areas which in turn make up the final index of design for instrument maintenance. An index number approaching 100 indicates the more desirable equipment.

▶ **Use Graphs to Find Index**—Let us suppose we are evaluating a mythical instrument. How do we use all these factors and subfactors?

Well, take Fig. 1, the graph depicting the maintenance index. The higher the index number, the better the instrument from the maintenance viewpoint. Each side of the graph stands for one of the four subfactors (required test equipment, spare parts, calibration and manuals) each of which is assigned an arbitrary scale. Now, the less test equipment needed, the better, so a low number on this scale is good. Of course, quantity of equipment needed is not the only consideration; we must also consider complexity, ease of operation, education required, and so on. Anyway, we scored this one 8 points.

Rating of spare parts requires information on 8 items, including availability of a complete spare-parts list, cost compared to original purchase price, availability of parts from factory stock, etc. We scored this as 88.

Calibration includes items such as zero and span adjustments, accessibility for adjustments, sensitivity, method of testing and other items. This gets 80 points.

Finally, manuals covers availability, quality and completeness of operating and maintenance manuals. We scored this 90 points.

We find our maintenance index by joining the points at opposite sides of the graph. A perpendicular from the diagonal of the graph to the intersection of these two lines gives the over-all maintenance index on the diagonal. For this instrument, it is 85.

In the same manner, we can obtain index numbers for component quality (77), design (81) and electrical characteristics (74). When all of these factors are charted on the maintenance composite graph, Fig. 5, we obtain an index number of 78, which is pretty good.

A competitive instrument, having less desirable maintenance design characteristics, though designed to perform the same service, received a rating of 73.

This method will help you to establish uniform standards for evaluation of instruments from the maintenance standpoint.

▶ **Complex Instrumentation**—Increasingly complex chemical processes and greater dependence on instrumentation for safe, economic operation have made higher quality instrument maintenance necessary.

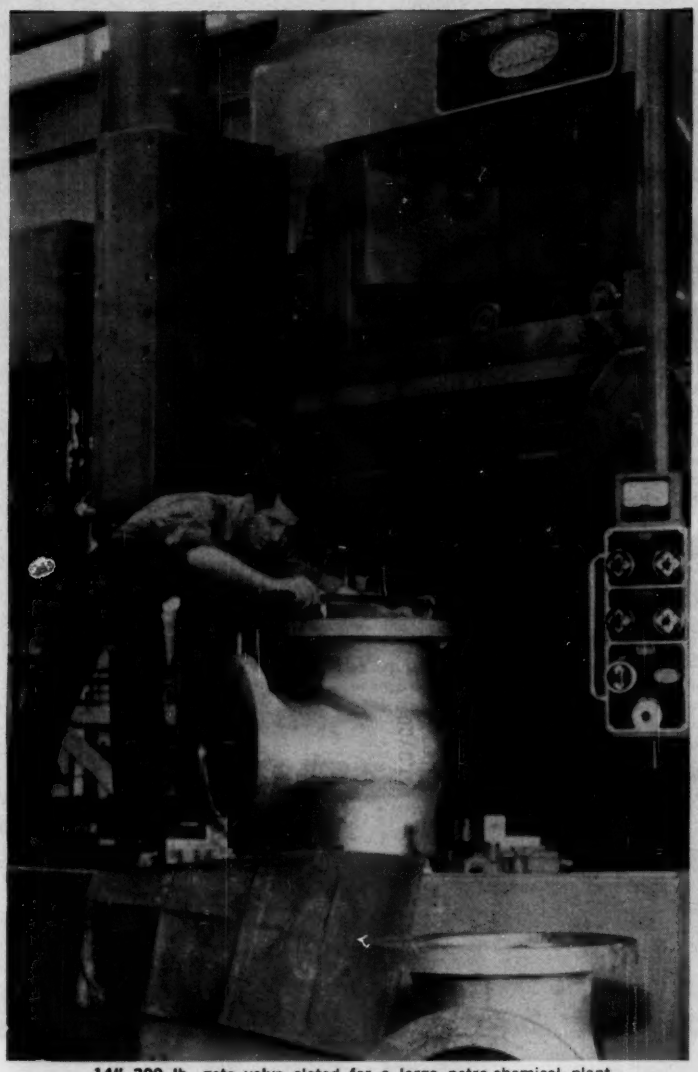
An optimum goal of an instrument maintenance program should be to insure that all of the instrumentation is available and operable when and as demanded by production requirements; instrument performance should not limit plant standards of safety, quality and quantity of production, or economic return on investment. Technical competence and past performance of the maintenance group should be such that instrument supplied information is not subject to doubt or question. Finally, these goals must be met at reasonable cost.

A maintenance philosophy that starts with heavy emphasis on better maintenance design in the original equipment will help achieve these goals of reliability, accuracy, and low cost.

Needless to say, the cost benefits management hopes to obtain through instrumentation will not be realized if it is necessary to recruit and train more and more maintenance personnel to keep the instruments functioning.

ARTHUR T. SHERMAN graduated from Lafayette College in Easton, Pa., in 1936. He is well qualified to write this article on instrument maintenance costs, having spent most of his professional life in the instrument field. His background includes sales and service engineering with Brown Instrument Co. and Precision Thermometer and Instrument Co. On the other side of the fence, Mr. Sherman was an instrument engineer for Socony-Vacuum Oil Co. and is now consultant supervisor, specializing in instruments, for DuPont with whom he has been for 9 years.

Mr. Sherman's background also includes a 50-month hitch in the Army as a major in the Corps of Engineers.



14" 300 lb. gate valve slated for a large petro-chemical plant, is being worked on one of Aloyco's battery of new Bullards.

Advanced machines... tools...test facilities expand Aloyco Valves' range of service

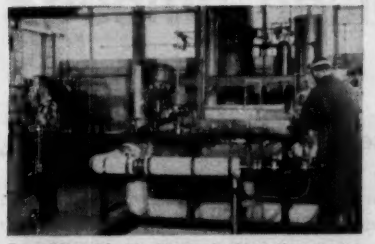
Constant change and improved techniques in modern fluid handling, pose a real challenge for valve manufacturers.

To meet these demands, Aloyco is constantly adding new facilities, some of which are pictured here.

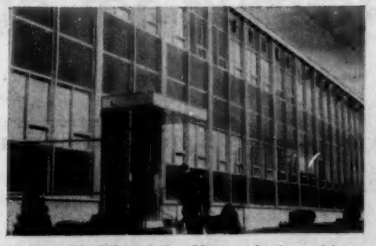
For example, Aloyco Stainless Steel Valves are now available in sizes up to 24", pressures up to 2,500 lbs. at 650°F.

While these new facilities have improved and expanded the quality and usefulness of our entire line, they are particularly important, for example, in the manufacture of valves for the nuclear and missile fields.

For advanced knowledge and ideas plus the equipment to carry them out—take your next valve problem to the specialists: Alloy Steel Products Company, 1301 West Elizabeth Avenue, Linden, New Jersey.



One of finest hot test loops in the nation checks out valves at up to 2500 psi, 650°F. Hot tests can spot trouble that would otherwise be revealed only after months of line service.



New multimillion dollar Aloyco plant combines new production tools, test facilities, sales, administration, research and development offices and labs into single integrated unit.

Boroscope examination (in pressurized clean room) of specially made nuclear valves follows the application of dye penetrant.

ALLOY STEEL PRODUCTS COMPANY

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Longer Lasting **ALOYCO VALVES**

FIT IN CORROSIVE SERVICE

Surfacing Process	Alloys or Metals Applied	Base Materials	Thickness, In. (Coating)	Max. Service Temp., F	Most Significant Advantages
Flame-plating	Tungsten carbide and cobalt binder	All metals, glasses, ceramics, etc.	0.002-0.010	1,000	Versatility of base metal selection because of low application heating. Can apply very thin coat.
	Chromium carbide plus Ni and Cr	All metals, glasses, ceramics, etc.	0.002-0.010	1,800	
Diffusion coating	Chromium, aluminum, silicon and combinations	Steels, stainless steels, nickel and cobalt alloys	0.001-0.006	1,600-2,000	High resistance to peeling. Coating is integral with base metal and causes only small dimensional changes. Can coat internal surfaces.
Hot-dip	Aluminum	Sheet steel	13 to 28 gage, including coating	1,250	Economical means of protection from heat and corrosion to 1,250 F. without destructive scaling.
Metallizing	Aluminum	Steel or iron	0.006	1,600	Does not alter base metal properties; good method for selective hardening.
	Ni-Cr alloy	Steel or iron	0.010	1,800	
	Ni-Cr alloy plus aluminum undercoat	Steel or iron	0.015 (Ni-Cr), 0.004 (Al)	2,100	
Hard-facing	Cobalt-, nickel-, or iron-base alloys, tungsten carbide	Most steels and irons	1/16-1/4	1,800	Usually the simplest application method. Practical where field repair may be needed later on.
Cladding and strip lining	Practically all corrosion-resistant alloys and metals	Carbon and alloy steel	Usually 14 to 16 gage wrought material	Depends on cladding material	Best corrosion-resistance. Of all surfacing methods, this most closely approximates solid metal.

New Surfacing Methods Vie With Old

For High-Temperature Process Applications

Metallic coatings—no panacea—permit maximum use of small quantities of expensive, high-performance materials.

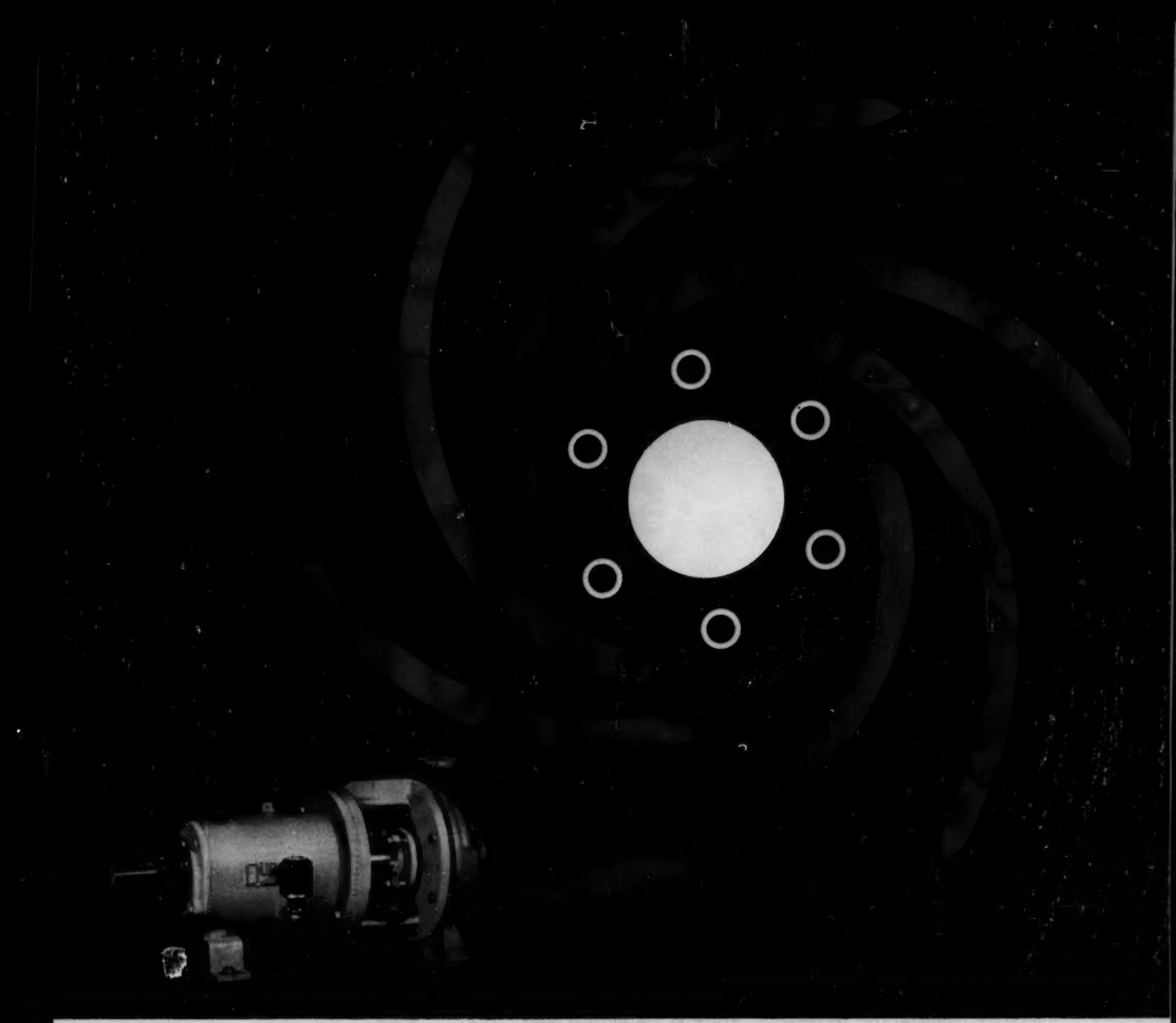
J. R. Schley, Haynes Stellite Co., Div. of Union Carbide Corp., Kokomo, Ind.

Only rarely can an engineer select a material of construction that is clearly superior to most others from all viewpoints.

More often than not, materials selection must be a compromise. Metal surfacing and coating represents one of the most economical ways of making this compromise when selecting materials for high-temperature equipment.

Good Compromise—The main advantage of surfacing is, of course, maximum use of small quantities of high-performance materials. A good example would be chemical-reactor strip lining with a nickel-base alloy. The alloy is applied only where it is needed to resist corrosion on the inside surface. The rest of the unit can be made of steel.

Another advantage involves use of materials with outstand-



Specific design for pumping corrosives

Here is the first pump designed specifically for long life in heavy duty corrosive service.

Durcopumps are made in fourteen standard alloys and special materials. Four bearing housings plus separate frame adapters give maximum interchangeability for all pump sizes.

Maintenance is short and sweet because the working parts can be removed as a unit—in minutes—serviced and reinstalled by a single trade. Pump casing, piping and motor are not disturbed.

Durcopumps are produced in standard, self-priming and vertical submerged designs. Pumps are available with heads to 345 ft., capacities to 3500 gpm, in sizes from 1" x 1" to 10" x 8". Standard operating temperatures to 500° F.

Call your nearest Durco Service Engineer or write for literature on your service application.

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

THE DURIRON COMPANY, INC., Dayton, Ohio / Pumps • Valves • Filters • Process Equipment

PLASMA-ARC produces platinum, tantalum, tungsten surfaces.

ing corrosion or abrasion resistance that, by themselves, do not have sufficient strength for a structural part. An example of this is a tungsten-carbide coating on rotary pump seals.

At ordinary temperatures, many materials are available to handle practically any type of process condition. However, as operating temperatures increase, this selection narrows considerably in the surfacing field.

Rubber linings are usually recommended to temperatures of about 250F. Most phenolic materials reach their limits at about 360F. Glass-lined equipment is not usually operated above 450F., although some equipment gives good service at temperatures as high as 600F. under special circumstances. From here on to the highest practical operating temperatures, metals and their alloys and compounds have an almost exclusive field.

▶ **High-Temperature Paints**—The one possible exception to this is the family of silicone and alkyd-resin paints pigmented with aluminum, nickel, bronze, or stainless-steel flake. Even though the alkyd will volatilize at about 500F., the silicone component has sufficient stability to hold metal until it fuses to the base. Such paints, formulated with aluminum, are recommended for temperatures of 500 to 1,200F. on metal smoke stacks, furnaces, and ovens.

▶ **Metals and Oxides**—By and large, however, metals and their refractory oxides are the most useful materials for the temperature range beyond 500F. They can vary in properties and price from aluminized-steel combustor parts to platinum-coated thermocouple junctures.

Aluminized-steel parts have good oxidation resistance in air at 1,200F. at the modest cost of about 40¢/sq. ft. Platinum-coated thermocouple wire would cost many hundreds of dollars per square foot but it turns out to be the most economical way of protecting against costly open circuits in control devices.

By far, steel is the most popular base material for surfacing. It can be covered with everything from silver to tungsten carbide.

Only at temperatures of about 1,800F. do other base materials seriously enter the picture: high-performance alloys are surfaced to increase their operating temperature limits. Most of the coating development work in this latter field has been directed towards improving aircraft alloys.

The table on p. 184 lists a variety of ways in which metallic surfaces can be applied. It is not complete, by any means, even in the high-temperature field. However, it does touch upon the more general methods for applying high-temperature surfaces and coatings.

Plasma-Flame Coats Anything

Flame plating is a process by which coating materials are blasted onto a base metal by special detonation equipment.

Usually, metal (or metal combination) powder feeds into a "gun" where controlled combustion of oxygen and acetylene or hydrogen heats and propels.

Temperatures of the molten coating material can reach 6,000F. However, the workpiece never goes over about 400F. during the process.

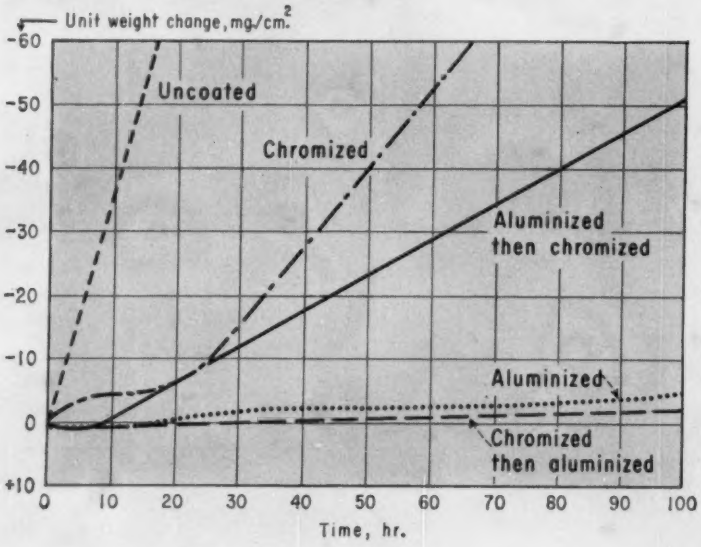
Principal advantages of the process are low heating of the base metal and a wide variety of materials that can be applied. In addition to the materials listed in the table, many other combinations of metals and metallic carbides, with varying properties, are possible. Aluminum-oxide coatings will resist temperatures up to 1,800F., depending on the metal underneath.

▶ **Highest Temperatures**—One similar but newer development—the plasma-arc spray—uses the highest controlled temperatures ever produced in industry (20,000F.).

Material (powder or wire) and an inert gas flow into an intense electric arc struck inside a torch. A high-temperature jet issues, at near sonic velocities, from a constricting orifice. Deposited particles are cooled with carbon-dioxide jets (see *Chem. Eng.*, Dec. 15, 1958, p. 67).

Ten basic plasma-coating materials have been established so far—tantalum, palladium, platinum, molybdenum, tungsten, alumina, zirconium diboride, and three combinations of tungsten with additives to improve its properties. Coatings of oxidation-resistant platinum have provided increased life, far beyond

Four Diffusion Coatings Boost Hastelloy alloy B's Resistance to Oxidation at 2,000 F.



anything tried to date, on thermocouples.

Diffusion Gives Strong Bond

Diffusion coating involves impregnating a metal surface with an element such as chromium, aluminum or silicon or combinations. In effect, this produces a new alloy on the surface of the base metal.

Parts to be coated are packed in retorts with the coating compound and heated over a period of time. In this respect, the process is related to carburizing and nitriding.

When aluminum is to be diffused, either the chloride or iodide of aluminum is used as the coating agent. Siliconizing is accomplished with silicon tetrachloride. Chromium fluoride or iodide act as carrier compounds in chromizing.

Chromizing as a commercial process is of comparatively recent origin although development work dates back at least 40 yr. Aluminizing and siliconizing processes have been employed commercially for many years.

Diffusion coating, while having certain drawbacks, offers a number of advantages over other surfacing methods. The intimate metallurgical bond between coating and base metal minimizes the possibility of peeling during thermal cycling. Migration of the halide vapor to the metal surface provides good penetration into recesses and pores.

▶ **Capacity Limitations.** — The most serious drawbacks of the process are limitations imposed by furnace and retort capacities on the size of articles that can be coated. Large cylindrical vessels would be extremely expensive to coat by this method. Therefore, the process is limited to volume production of small parts.

Practically all ferrous and nonferrous alloys can be diffusion treated, very often with dramatic results. For instance, chromized SAE 1010 steel gains only 2 to 5 mg./sq. cm. when held at 1,200F. for 1,000 hr. Similarly exposed nickel-silver gains 67 mg./sq. cm.; unprotected steel gains 1,620 mg./sq. cm.

At the present time, combinations of different diffusion coatings applied to high-performance alloys are being investigated. Some metals, such as molybdenum, and columbium, have good strength properties, but poor oxidation resistance in the 2,000F. range. Although still in the developmental stages, diffusion coatings may permit increased use of these strong materials at high temperatures.

The curves shown here illustrate the improvement in 2,000F. oxidation resistance achieved by diffusion-coating Hastelloy alloy B. This high - molybdenum, nickel-base alloy has only limited oxidation resistance and is normally used at temperatures below 1,500F.

Hot-Dip: Economical

Aluminum is the only hot-dip coated metal used extensively for high-temperature service. Coating of sheet steel with aluminum by dipping is a continuous production process.

Material comes coated on both sides. In this form it is handled and worked in practically the same manner as ordinary steel.

Aluminum-coated steel is used for stacks, weather shields and other external structures in process plants that are exposed to atmospheric conditions. Steel, coated in this manner, can be used to temperatures of 1,250F. without destructive scaling. It is one of the most economical methods of protecting structural parts from oxidation in this temperature range. Above 900F. the coating begins to alloy with the steel base, forming a tight grey surface layer of iron-aluminum alloy.

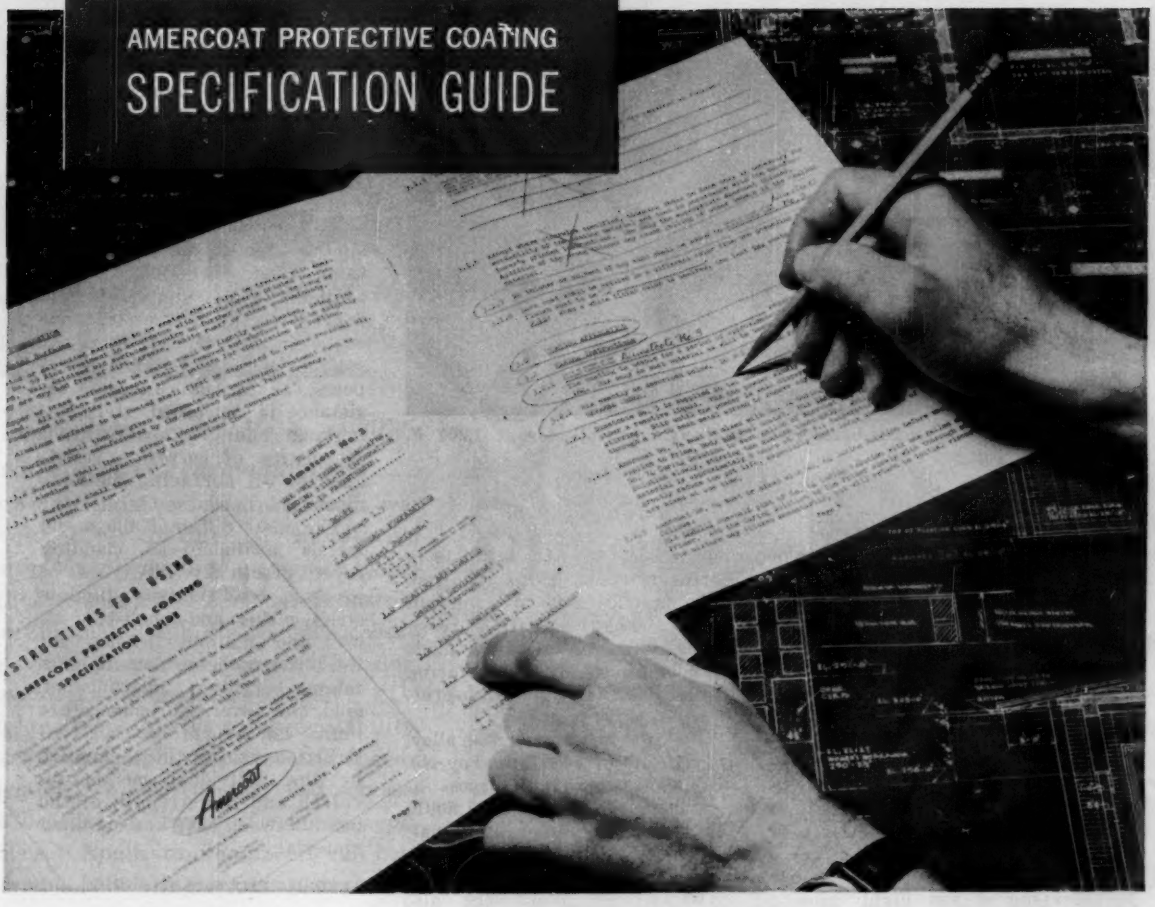
A typical application involves a catalytic combustion unit converting waste fumes to odorless, colorless gases. In this instance, the aluminum-coated steel handles temperatures up to 1,200F.

Spray Is Abrasive Resistant

Spray coating, commonly known as metallizing, is another method by which metal can be applied to the surface of a base material, sometimes even cloth or paper.

Metal wire feeds through an acetylene-oxygen flame into a stream of high-velocity air, which drives molten metal onto the prepared surface. This air, plus application on a cold material, makes it possible to keep sprayed objects at comparatively low temperatures.

In general, spray coating is



Here's the Beginning of a Good Coating Job

Tight, comprehensive specifications are the beginning of a successful protective coating application. Unless specifications are complete and detailed, costly failures or confused, inaccurate bidding can result.

Now, engineers who write specifications for protective coating applications can insure complete, accurate specifications through use of the new Amercoat Protective Coating Specification Guide.

The Guide is based on recognized best practices in the industry, such as Steel Structures Painting Council Specifications, and contains paragraphs covering all phases of coating application from surface preparation to inspection.

In use, appropriate paragraphs in the Guide are selected according to the coating to be used and the condition involved. At this step, your Amercoat Sales Engineer will be pleased to cooperate with you in deciding upon the most effective coating or coating system for the job requirements. The finished specifications can then be copied by a typist.

Use of the Amercoat Specification Guide assures tight specifications that spell out every step necessary to eliminate confusion when the contractor bids and to insure a satisfactory application later. Job delays and extras are reduced or eliminated and a well applied coating job is assured.

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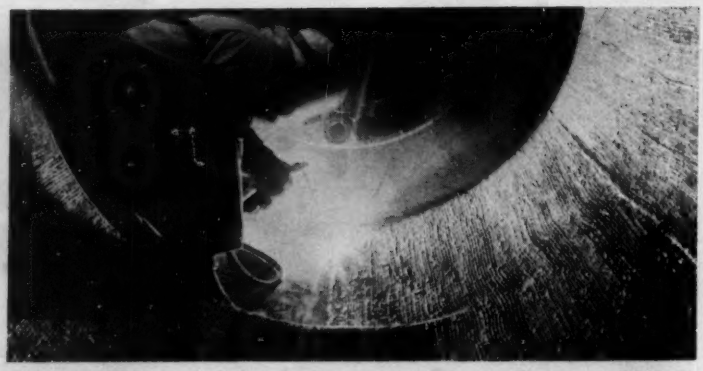


HARD-FACING: cobalt-based alloy protects dust collector at 1,200 F.

used for protecting parts from abrasion and the corrosive action of hot gases. It affords protection over a wider temperature range than the dip surfacing method.

For wet-chemical corrosion, spray coating has never been considered completely satisfactory for Hastelloy corrosion-resistant alloys because of porosity; although there have been some very successful specialized applications, notably pump shafts. Generally speaking, spraying of any highly alloyed material to steel will increase steel's corrosion resistance. In the case of Hastelloy alloys, spraying does not leave them in a very good corrosion-resistant form.

Numerous parts are successfully protected by metal spraying, however, and nickel-chromium alloy on top of aluminum is recommended for applications up to 2,100F. Examples are furnace and kiln parts, and pyrometric equipment subjected to sulfur-bearing gases.

Hard-Facing by Welding

Hard-facing, in which an alloy is applied to the surface of a metal part with standard welding equipment, is probably the oldest and still one of the most common methods for producing wear- or heat-resistant surfaces. A great variety of cobalt-, nickel-, and iron-base alloys are available for many different service conditions.

As in the case of spraying, this process of protection is never used where the ultimate in corrosion resistance is required. Most applications are for hot abrasion and oxidation resistance. Wide use has been made of cobalt-base alloy hard-facing for valves handling high-pressure steam.

Deposits of a cobalt-base alloy, such as Haynes Stellite alloy No. 6, retain effective hardness at temperatures up to 1,800F. Nickel- and iron-base materials soften at slightly lower temperatures.

Nickel-base alloys are also used to protect equipment against high temperatures. One valve manufacturer coats gate valves with Hastelloy alloy B to protect them from oil at temperatures of from 350 to 1,000F., where impurities such as sulfur or hydrogen sulfide are usually present.

Perhaps one of the largest single uses of hard-facing for high-temperature service is in catalyst recycle systems of catalytic-cracking units. Most of these units are surfaced with either cobalt- or iron-base alloys to protect them from abrasion of rapidly flowing catalyst beads at process temperatures of up to 1,400F.

Cladding, Strip Lining

As the name implies, strip lining is accomplished by surfacing with individual sections of alloy sheet.

This technique is commonly employed with steel vessels. Sections are formed to the contour of the inner wall, then welded together to form a continuous liner. Numerous techniques have been developed for keeping exposed welds undiluted by the base metal (see *Chem. Eng.*, Dec. 29, 1958, p. 70).

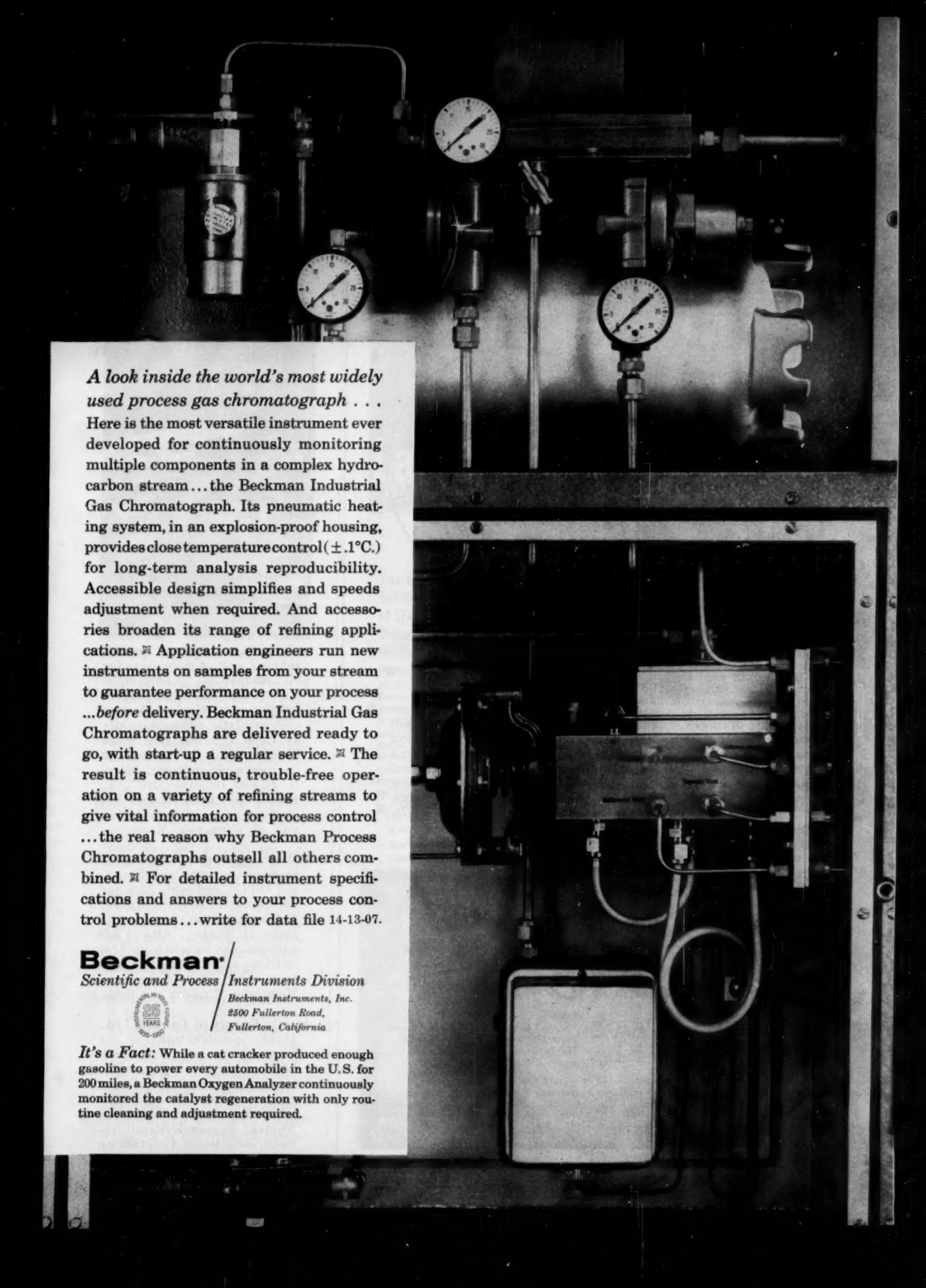
More recently, integrally clad metal construction has found favor for many similar applications. Clad sheet and plate are available from a number of producers. It can be handled generally in the same manner as solid metal. For all practical purposes, as far as corrosion resistance is concerned, strip lining and cladding afford the highest degree of corrosion resistance of all surfacing methods discussed here.

The many different alloys and metals available as cladding cover practically all types of process conditions — stainless steels, nickel- and cobalt-base alloys, and titanium. Development work is now being done on tantalum, beryllium, molybdenum, gold, and silver. No temperature limits can be put on clad construction except those imposed by the individual metals involved and the strength of the bond between base and cladding material.

ACKNOWLEDGEMENT

The author is indebted to the following companies for their assistance and information on their products or processes: Armco Steel Corp., Middletown, Ohio; Chicago Bridge and Iron Co., Chicago, Ill.; Chromalloy Corp., White Plains, N. Y.; Linde Co., Div. of Union Carbide Corp.; Metallizing Engineering Co., Inc., Westbury, L. I., N.Y.; and Silicones Div., Union Carbide Corp.

JOHN R. SCHLEY is manager of the technical services section of Haynes Stellite's development laboratories. He also supervises a corrosion-engineering group and the corrosion laboratories. A graduate of the Univ. of Wisconsin, with a B.S. in chemical engineering, Mr. Schley has worked on corrosion and high-temperature problems for a number of years, but lately he is specializing on oxidation testing of metals and alloys and the study of high-temperature corrosion mechanisms.



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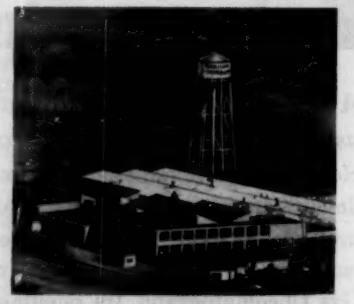
It's a Fact: While a cat cracker produced enough gasoline to power every automobile in the U.S. for 200 miles, a Beckman Oxygen Analyzer continuously monitored the catalyst regeneration with only routine cleaning and adjustment required.

INDUSTRY NEWS . . .

(*Continued from p. 94*)

tion of its Niagara Falls facilities, to cost from 11 to 12 million dollars. Niagara Falls modernization is part of a $17.8-million company wide improvement and expansion program for 1960.



Barium and Chemicals, Inc. is moving into this newly purchased plant at Steubenville, Ohio. B & C thus ups its production potential for high-purity barium and strontium chemical compounds.

Bechtel Corp. has just completed installation of several refinery units for three major oil companies: Continental Oil Co. has placed on stream its new catalytic desulfurizer and catalytic reformer units at Lake Charles, La.; Esso Standard Oil Co. started up its light-ends unit at Linden, N. J., and Imperial Oil, Ltd., placed on stream its new hydrofluoric acid alkylation unit at Winnepeg, Man.

British American Oil Co. is teaming up with Calif. Standard Oil Co. and some 25 other companies to operate a giant $12.5-million gas processing plant at Rimbey, Alta. BAO will process as much as 326-million cu. ft./day of gas from the Dick Lake and Homelglen Rimbery gas fields.

Atomic Energy of Canada, Ltd., plans construction of a second nuclear research center near Winnepeg, Alta., to supplement existing facilities at Chalk River. New laboratory, named Whiteshell Nuclear Research Establishment, will begin functioning

by the end of the year; among its first projects will be studies of the organic-cooled, natural - uranium - fueled, heavy-water-moderated reactor concept.

Canadian Oil Co., Ltd., is going ahead with $3-million plans for construction of 10,000-bbl./day crude-oil processing and 11-million-cu. ft./day gas recovery plants at its Innisfail gas field in Alberta. Plants are designed to extract crude oil, recover sales gas and sulfur. Canadian Oil contracted Ralph M. Parson to construct the plant, to be operated by Canadian Oil for some 12 petroleum companies.

Florida Nitrogen Co., a subsidiary of Southern Nitrogen Co. of Savannah, Ga., opened this $2-million Tampa, Fla., plant last month. Production of calcium ammonium nitrate and nitrogen solutions has begun and nitric acid production will begin soon.

Honeymead Products Co. recently completed expansion of its combination soybean and flaxseed solvent extraction plant at Mankato, Minn. Honeymead contracted Engineering Management, Inc., Park Ridge, Ill., to perform design, procurement, construction and supervision services for the 23,000 bushel/day expansion.

Marathon, a pioneer producer of wood chemicals, is installing spray dryer equipment to produce 50 tons/day of dry ligno-sulfonate at its Green Bay, Wis., pulp and paper mill. Stainless-steel unit, supplied by Nichols Engineering and Research Corp. features a centrifugal atom-

izer and a direct-fired air heater with dual facilities for gas or oil burning.

Ethyl Corp. is constructing a vinyl chloride monomer plant at its Houston, Tex., plant to supplement VC capacity at Baton Rouge; Ethyl hopes this will meet anticipated demands by PVC industry.

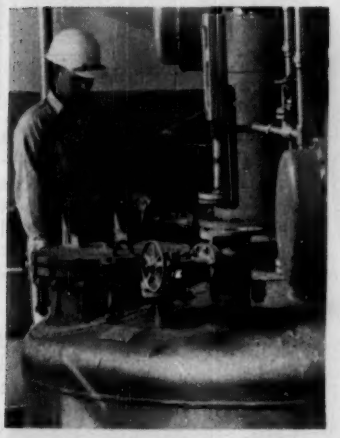
Stauffer Chemical Co. is meeting new demand by American Chemical Corp. for chlorine by expanding its Henderson, Nev., chlorine-caustic plant. American Chemical is a major producer of chlorinated hydrocarbons.

Western Petroleum Corp. has added several new petrochemical processing units to its Chanute, Kan., refinery; a propane deasphalting unit, several vacuum distillation units and a TCP wax treater for continuous wax bleaching.

National Beryllia Corp., North Bergen, N. J., meets rising demand for beryllium oxide head on by placing on stream the nation's largest production facility at its Haskell, N. J., plant. NBC supplies ultra-high temperature (melting point 4,650 F.) beryllium oxide to missile, electronics and nuclear industries. High-temperature ball kiln (above) hard fires NBC ceramic products.

Pennsalt Chemicals Corp. discloses plans for expansion of its Index Chemical subsidiary, producer of hydrogen

sulfide in the Houston, Tex., area. Pennsalt readies itself for rising demand for organosulfur compounds with this $1-million investment in hydrogen sulfide capacity.



Catalin Corp. of America placed this new 5,000-ton/yr. acrylic plant on stream last month at Fords, N. J. New plant and process-equipment design patterns after that of Union Chimique Belge, S. A., Brussels, Belgium, under a cross-licensing and technical-information exchange agreement. Catalin has geared its new plant, adjoining its Central Research Lab., for acrylic emulsion and solution development and production.

Dow Chemical Co. nears completion of a new polyethylene film plant at Fresno, Calif. Rapid construction schedule calls for plant startup by the spring.

DuPont of Canada, Ltd. announces startup of new nitric acid capacity at West Ferris, Ont., for explosives manufacture. An undisclosed portion of the 60-ton/day nitric acid output will be used for ammonium nitrate manufacture.

H. K. Porter Co.'s Refractories Div. is laying the groundwork for a $4-million modernization and expansion. Present plans include construction of storage, tunnel kiln, brick making and drying facilities at Bessemer, Ala., and con-

struction of tunnel kiln and drying equipment at Wellsville, Ohio.

Flo-Tronics is the name of a new Minneapolis, Minn., corporation which now designs systems for automatic bulk handling of chemical and food materials. New company specializes in pneumatic conveying of solids.

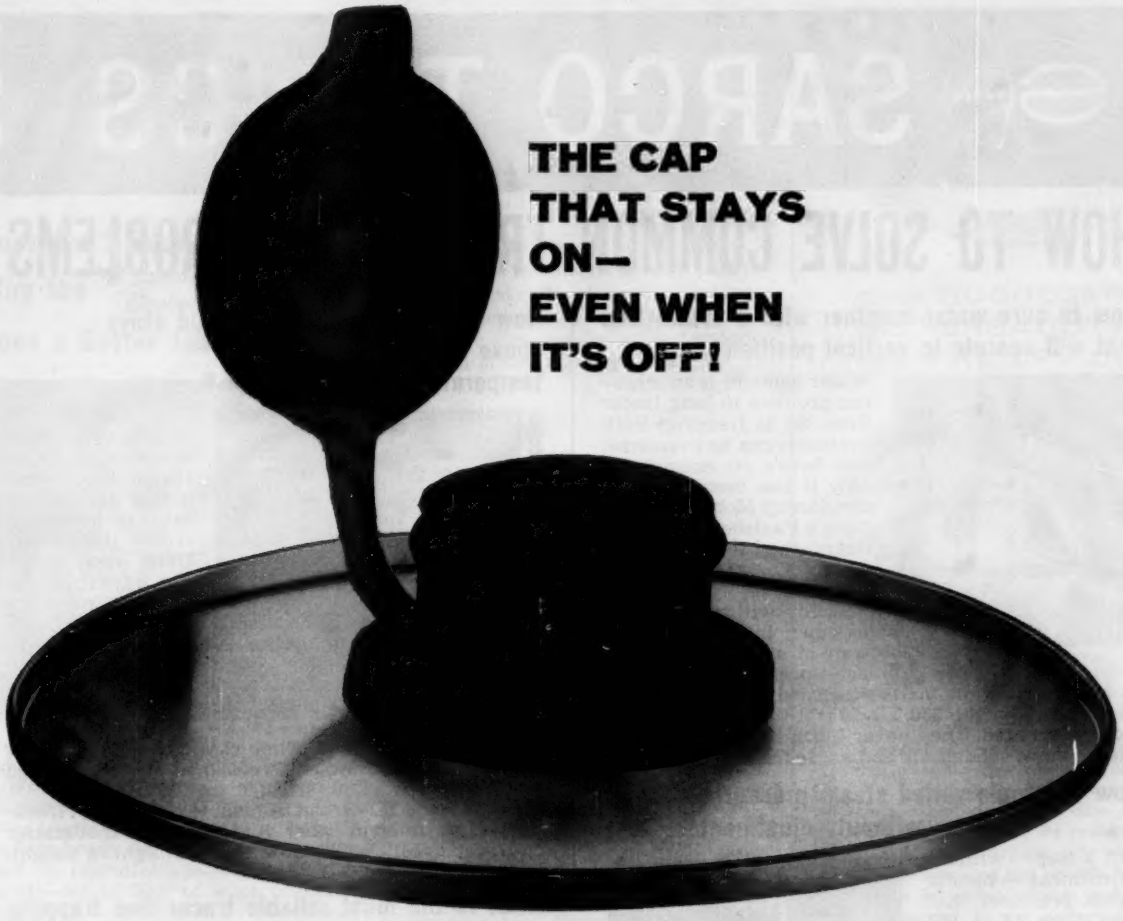
Niagara Chemical Div. of Food Machinery and Chemical Corp. has formed a Western Agricultural Dept. in Fresno, Calif., to improve technical information and sales service.

The Richardson Co., rubber and plastics-products producer, has formed Treplow Chemical Co. to produce organic chemicals and synthetic resins for detergent, cosmetic and dry cleaning industries; Richardson is expanding existing production facilities at Paterson, N. J.

Union Oil & Gas Corp. and Texas Natural Gasoline have agreed to merge into a giant $250-million company, to be headquartered in Houston, Tex. Union President, Richard T. Lyons, points merger as one that will "enhance future growth possibilities of each of the enterprises and their joint profit outlook."

Hercules Powder Co. announces the purchase of Nitro-Form Agricultural Chemical Co. of Woonsocket, R. I. NFA specializes in urea-formaldehyde fertilizers for certain purposes.

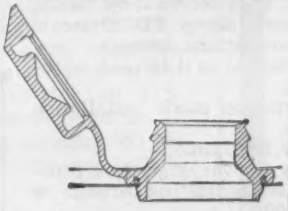
Lockheed Aircraft Corp. again declares interest in the rocket and missile industry by acquiring 50% interest in Grand Central Rocket Co., Redlands, Calif. GCR is the



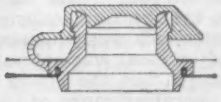
CONTINENTAL'S NEW ALL-PURPOSE FLIP CAP*

Continental presents new packaging beauty with economy and convenience, too... Flip Cap* can, with dripless pour spout, is perfect for practically all liquids and granulated products now packaged in round or oblong nozzle-type cans.

Continental's new plastic Flip Cap is permanently hinged to its dripless pour spout—snaps back and stays open, snaps shut and stays shut. Inserted into the top of the can *after* filling, Flip Cap permits higher filling speeds through a larger opening. And the top of the container can be fully lithographed—no solder splashes, no flux spots or heat scorching. For the full story, ASK THE MAN FROM CONTINENTAL!



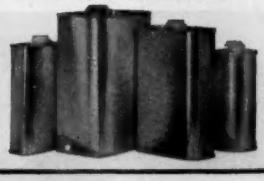
Cap can't be lost—permanently attached by a hinge. Flip Cap is available in either ½- or ¾-inch opening, and in a variety of colors.



Applied after filling, Flip Cap nozzle can be inserted automatically at 200 per minute. Full lithography on top of can.

*Patents pending

Available in a wide variety of sizes and shapes



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nation's fourth largest firm in the solid propellants field; thus Lockheed rounds out its missile capabilities to cover the full gamut.

Frank B. Green, Inc. is a new name in the pulp and paper industry's bright lights; Green specializes in continuous digester design, is located in Massapequa Park, N. Y.

OVERSEAS BRIEFS

Israel: Fertilizers & Chemicals, Ltd. is establishing Industrial Chemical Equipment, Ltd., to design and manufacture equipment for the nation's rising $10-million market. ICE plans to represent foreign design companies, as a close contact with present Israel CPI.

Netherlands is buzzing with plans for industrial expansion, too. Montecatini reveals plans for construction of a chemical complex at Axel in the extreme Southwest of Netherlands. Union Chimique Belge, S. A. has awarded Badger, N. V. a $2-million contract to build a 5,000-ton/yr. phthalic anhydride plant at Schoonarde; when completed new plant will produce as much as 5,000 metric tons/yr. of product. On the nuclear front, Euratom announces plans for an $18-million research center at Petten, to house some 600 research engineers and scientists.

West Germany: Newly formed Carbosuf Chemische Werke, Gmbh., in Cologne; a subsidiary of Courtalds, Chemische Fabrik and Bad Kreuznach; is building a 52,000-ton/yr. carbon disulfide plant at Cologne. Nearby petrochemical plants will supply feed materials, to be processed under a Food Machinery Corp. license.

CALENDAR

Institute of Radio Engineers, national convention, Waldorf Astoria Hotel & New York Coliseum.
March 22-24 New York, N. Y.

Oil Trades Assn. of New York, meeting, Waldorf Astoria.
March 23 New York, N. Y.

New England Gas Assn., annual meeting, Statler-Hilton Hotel.
March 24-25 New York, N. Y.

Textile Research Institute, annual meeting, Hotel Commodore.
March 24-25 New York, N. Y.

Material Handling Institute, Inc., Pittsburgh Hilton Hotel.
March 28-29 Pittsburgh, Pa.

Western Petroleum Refiners Assn., annual meeting, Hilton Hotel.
March 28-30 San Antonio, Tex.

American Institute of Chemical Engineers, Philadelphia-Wilmington Section, all-day meeting: Separation Processes, University of Pennsylvania.
March 29 Philadelphia, Pa.

American Power Conference, sponsored by Illinois Institute of Technology, Hotel Sherman.
March 29-31 Chicago, Ill.

American Society of Mechanical Engineers, Power Conference, Sherman Hotel.
March 29-31 Chicago, Ill.

American Oil Chemists Society, meeting, Baker Hotel.
April 3-6 Dallas, Tex.

Nuclear Congress, sponsored by Engineers' Joint Council and Engineering and Scientific societies, New York Coliseum.
April 3-8 New York, N. Y.

American Oil Chemists Society, annual meeting.
April 4-6 Dallas, Tex.

American Management Assn., National Packaging Exposition and Conference, Convention Hall.
April 4-7 Atlantic City, N. J.

Instrument Society of America, New Jersey Section, all-day symposium: Computers in the Process Industry, Essex House.
April 5 Newark, N. J.

Building Research Institute, Paints and Coatings Conference, Statler-Hilton Hotel.
April 5-7 New York, N. Y.

Instrument Society of America, National Chemical and Petroleum Symposium.
April 5-7 Rochester, N. Y.

American Society of Mechanical Engineers-Society for Advancement of Management, Management conference, Statler-Hilton Hotel.
April 7-8 New York, N. Y.

Management Seminar, sponsored by Cornell University, fee: $900, Statler Inn, Cornell Campus.
April 13-26 Ithaca, N. Y.

American Society of Mechanical Engineers-Institute of Radio Engineers-American Institute of Electrical Engineers, third annual conference on Automatic Techniques. Cleveland-Sheraton Hotel.
April 18-19 Cleveland, Ohio

Stanford Research Institute, Symposium: Chemical Reactions in the Lower and Higher Atmospheres, Mark Hopkins Hotel.
April 18-20 San Francisco, Calif.

American Society of Lubrication Engineers, annual meeting and exhibit. Netherland-Hilton Hotel.
April 19-21 Cincinnati, Ohio

Oklahoma State University, heat-transfer conference.
April 20-22 Stillwater, Okla.

National Petroleum Assn., semi-annual meeting, Cleveland-Sheraton Hotel.
April 20-22 Cleveland, Ohio

Instrumentation for the Process Industries, symposium sponsored by Texas A. & M.
April 20-22 College Station, Tex.

German Industries Fair, Hanover Fair Grounds.
April 24-May 3 Hanover, W. Germ.

Society of the Plastics Industry, annual Canadian Section conference, London Hotel.
April 25-26 London, Ont.

American Society of Mechanical Engineers, Maintenance and Plant Engineering Conference, Chase-Park Plaza.
April 25-26 St. Louis, Mo.

American Society of Mechanical Engineers, Metals Engineering Div., AWS Conference, Biltmore Hotel.
April 25-29 Los Angeles, Calif.

Natural Gasoline Assn. of America, annual convention, Rice Hotel.
April 27-29 Houston, Tex.

Electrochemical Society, national meeting, Lasalle Hotel.
May 1-5 Chicago, Ill.

Western Joint Computer, Conference, Fairmont Hotel.
May 2-6 San Francisco, Calif.

Canadian Dept. of Mines and Technical Surveys, Conference: Methods of Reducing Iron Ores, Lasalle Hotel.
May 3-5 Chicago, Ill.

Society of Chemical Industry, Chemical Engineering Group, international symposium on distillation, The Dome.
May 4-6 Brighton, England

Instrument Society of America, Instrument-Automation Conference and Exhibit, Brooke Hall and Civic Auditorium.
May 9-12 San Francisco, Calif.

Oklahoma State University, Industrial Operations Analysis Conference.
May 9-11 Stillwater, Okla.

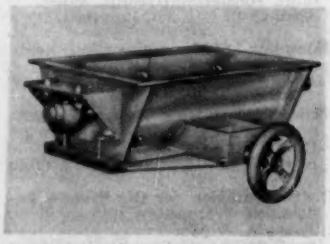
Southwestern Metal Congress, and Exposition, Sheraton-Dallas Hotel and State Fair Park.
May 9-13 Dallas, Tex.

American Institute of Industrial Engineers, annual meeting, Dallas Sheraton Hotel.
May 12-14 Dallas, Tex.

NEW EQUIPMENT . . .

(*Continued from page* 112)

of a remote indicator to determine gate position is possible.—**Vacuum Research Co., San Francisco, Calif.** 112D

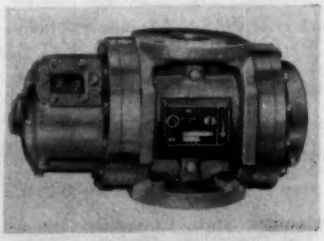


Roll Crusher

Addition to standard line for highest throughputs.

Efficient and economical size reduction of a wide variety of materials is the function of a new, 24-in., single-roll crusher. Standard construction is carbon steel, but the machine also comes, when required, in stainless steel.

Design features include: sturdy steel hopper; outboard bearings and packing glands; adjustable rotor; direct or remotely controlled slide gate; and a shear-pin sheave-drive assembly that protects the crusher from damage in the event of overload.—**Sprout, Waldron & Co., Inc., Muncie, Ind.** 202A



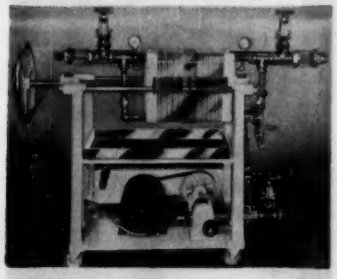
Gas Meter

Compact unit offered for low-capacity service.

Employing rotary, positive-displacement design, the new 3M125 gas meter has a flow range to 3,000 cfh. and a working pressure to 125 psig. De-

scribed as "just a bulge in the line," the unit can be flange-mounted directly in either a horizontal or vertical line without need for additional support. High accuracy, low cost and straight-through flow construction are among the meter's features.

Constructed primarily of cast iron, and sealed against gas leakage by an impregnation process, the meter has a weight of less than 55 lb. The volume register or counter reads directly in cubic feet of displaced gas.—**Roots-Connersville Blower, Connersville, Ind. 202B**



Duplex Filter

Plate-and-frame unit can filter twice per pass.

Designated EFS Duplex Model, a new filter enables single or double filtration in one operation. According to the manufacturer, it is ideal for operations where some liquids require both primary and polishing filtration, while others require only a single pass. Either standard or sludge-type inlet frames are offered.

Liquid-contacting parts come with either stainless steel or nickel-plated rod materials of construction. Size range extends from 10 to 100 sq. ft. Pump, motor and pressure controls are optional.—**Ertel Engineering, Kingston, N. Y. 203A**

Polypropylene Block

Construction material for prototype fabrication.

A complete line of polypropylene block enables users to make prototypes of many proc-

ess equipment items such as pillow blocks, bearings, valves, laboratory equipment, etc. Easily machined, ground, drilled, threaded and welded, polypropylene components are ideal for elevated temperature and rigid construction service.

Block sizes range from 1 x 12 x 12 in., weighing 4.7 lb., to 3 x 12 x 24 in., weighing 28.2 lb. Prices range from $11.75 to $63.45 per block.—**American Agile Corp., Bedford, Ohio. 203B**

Cubic Air Filter

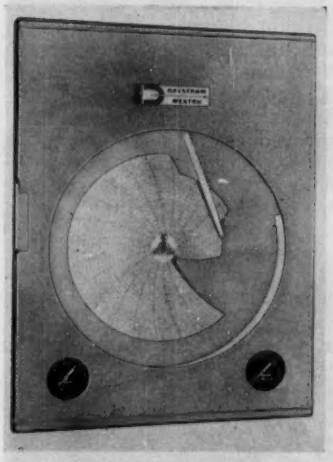
Fines bypassing main face are trapped by sides.

Substantial savings in filter costs are possible with a new "cube" replacement air filter. While combining high efficiency with low pressure drop, the ULOK offers a service life at least six times longer than conventional throw-aways and permanent metal-type filters, according to the manufacturer.

High-capacity filtration of ULOK is attributed to the light weight Dynel modacrylic filtering medium, a uniquely processed filter batt and open-side cube construction.

In operation, the air stream carries dirt onto the front surface of the downstream face of the filter. As dirt builds up on this face, air flow shunts to the side of the cube. Result of this progressive "reverse loading"

is a low pressure drop, even after collection of several pounds of solids. Initial rating is 0.04 in. pressure drop at 2,000 cfm. Several standard face areas are available.—**Union Carbide Development Co., New York, N. Y.** 204A



Program Transmitter

Available with choice of several cam drives.

Built for ruggedness, the new Model 7002 pneumatic program transmitter with interchangeable cams offers a choice of 1-, 8-, 12- or 24-hr. and 7-day cam drives. The instrument will handle one or two transmission systems, transmit a 3 to 15-psi. pneumatic signal, and can be used with single or double cams.

Each unit comes with universal mounts—flush or surface—and is encased in a dust- and moisture-resistant metal cabinet. Transmitters feature bridge-type pointer suspension; all internal components are mounted on the base plate.—**Daystrom, Inc., Weston Instruments Div., Newark, N. J.** 205A

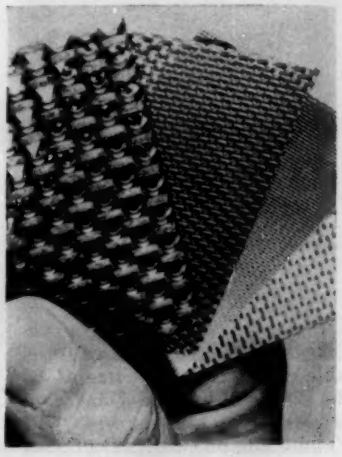
Industrial Fans

Basic design adaptable to several wheel styles.

Exhausting of gases and corrosive fumes and pneumatic handling of granular or fibrous

materials are typical applications for a new line of industrial fans. Three blade shapes, a wide range of wheel and inlet sizes, and five arrangements to meet most requirements are available. Maximum wheel size is 64-¾ in.

Exhaust wheels have back-inclined blades for top efficiency. For pneumatic conveying systems, the wheel has straight blades; side plates are optional. Housings are of sturdy steel construction with horizontal and vertical reinforcement. Access doors speed cleaning and reduce the cost of maintenance.—**Trane Co., La Crosse, Wis.** **205B**



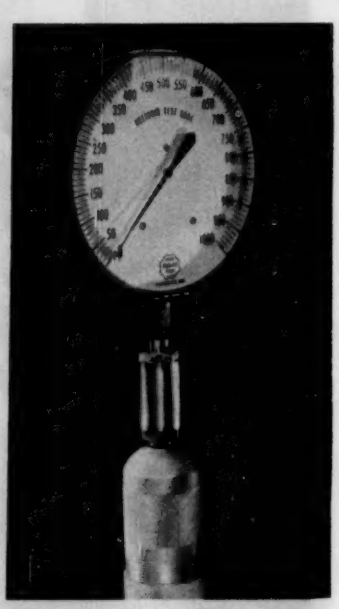
Pierced Sheet

Triples screen life and increases throughput.

Conidure, a new pierced-metal sheet, lasts up to three times longer than perforated metal for screening, recovering or dewatering operations. Also according to the manufacturer, throughput efficiencies with Conidure are substantially higher than possible with perforated metal screens previously available.

Sheet thicknesses range from 0.014 to 0.079 in.; hole diameters (trapezoidal in shape) range from 0.004 to 0.099 in.; sheet thicknesses up to seven times hole diameter are possible. Several materials of construction, with many degrees of

surface finish are offered.—**Cross Perforated Metals, National-Standard Co., Carbondale, Pa.** **206A**



Gage Connection

Permits rotation of gage face to any direction.

A new, leakproof connection for pressure gages rotates at the top to allow turning of the gage's face for easy reading from any direction, even under pressure. Tightening or loosening of threaded joints (after first proper makeup) is unnecessary.—**Macco Oil Tool Co., Inc., Houston, Tex.** **208A**

BRIEFS

Variable resistance device, directly controls up to 0.25 kw. power in response to as little as 0.0001 in. mechanical displacement. Called the Regohm Transducer, the instrument is direct acting, and comes as a compact package capable of any mounting position. Any process or machine quantity that appears as a change in position will move the unit's actuator to initiate control: Bending of a

heat-sensing bimetal; fluid pressure on bellows; etc.—**Electric Regulator Corp., Norwalk, Conn.** 208B

Repetitive operation (high-speed) is now an option for all PACE 231R analog computers. Addition of this feature provides the computer's operator with a highly accurate, extremely versatile means of solving a variety of engineering problems that would be difficult through "real time" techniques alone. Solution appears as a continuous plot on the 17-in. display screen.—**Electronic Associates, Inc., Long Branch, N. J.** 210A

Liquid-level control features a new, low-cost design in which all parts of the control in contact with liquids or vapors are nonmetallic. Polyvinyl chloride is the material of construction used in Magnetrol Models NM-1 and NM-2. Useful for specific gravities of 0.70 or above, the devices are capable of service at 100 psi. and 70 F., or 50 psi. at 140 F. —**Magnetrol, Inc., Chicago, Ill.** 210B

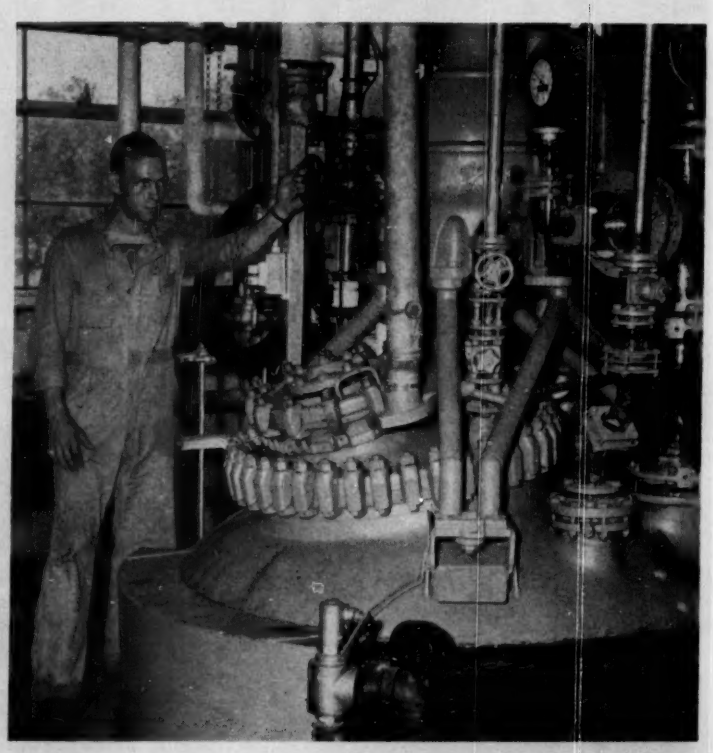
Equipment Cost Indexes . . .

	Sept. 1959	Dec. 1959
Industry		
Avg. of all	235.8	231.0
Process Industries		
Cement mfg.	229.9	231.1
Chemical	237.5	239.0
Clay products	223.4	224.6
Glass mfg.	224.2	225.6
Paint mfg.	228.0	228.7
Paper mfg.	228.8	230.2
Petroleum ind.	232.9	233.6
Rubber ind.	235.7	236.5
Process ind. avg...	234.1	235.4
Related Industries		
Elec. power equip...	239.4	242.1
Mining, milling	239.0	240.4
Refrigerating	266.4	267.3
Steam power	223.2	223.9

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124—6 for method of obtaining index numbers; Feb. 23, 1959, pp. 149-50 for annual averages since 1913.

TECHNICAL BOOKSHELF

J. E. BACON



Chemical reactor: The hand that turns the profit.

For the Process Designer

REACTION KINETICS FOR CHEMICAL ENGINEERS. By Stanley M. Walas. McGraw-Hill Book Co., Inc., New York. 338 pages. $9.50.

Reviewed by Charles N. Satterfield, Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

The cost of a modern chemical plant is chiefly in its unit operations equipment, but its profitability is largely determined by what happens in the small unit labeled "chemical reactor." This has been attested to by the recent rapid increase of publications on applied kinetics and the postwar appearance of several books in the field.

Walas focuses his treatment from the viewpoint of the process designer, and indeed this book might more descriptively have been entitled, "Process Design of Chemical Reactors."

There is much here to be admired. The book is well organized and the literature coverage is thorough and up-to-date. Many real design problems are worked out in detail to illustrate design methods. The large number of unsolved problems at the end of

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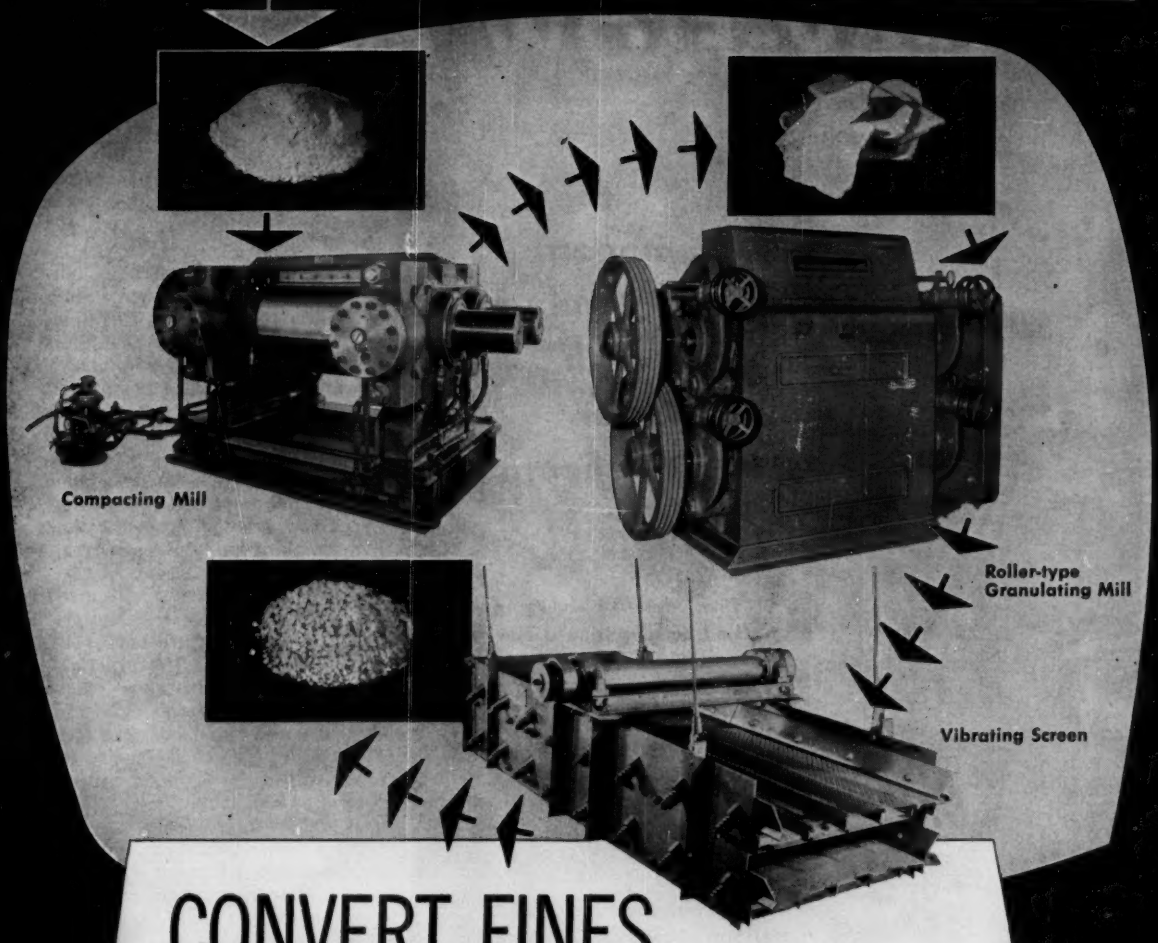

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the chapters, frequently involving recent data from the literature, will be welcomed by instructors using this as a text.

Novel features of the book include a chapter on heterogeneous reactions (in contrast to heterogeneous catalytic reactions), material on fluidized beds, and treatment of simultaneous gas solution with chemical reaction. A descriptive chapter on industrial reactors, which includes a considerable number of line drawings of pieces of equipment, reminds the reader that the flow patterns of heat and mass are in fact far more complex than those implied by the squat blocks and thin rectangles by which chemical reactors are usually represented on flow sheets.

The principal reservation of this reviewer concerns the decision of the author to treat the fundamental concepts of reaction kinetics in brief and superficial fashion. Perhaps, as the preface states, these "are not of immediate value to the practical design of industrial reactors." However, they do determine in what way and how precisely we are entitled to formulate the reaction rate in the first place.

Chemical engineers concerned with research and development on new reactions and analysis of old ones will need a clearer and deeper insight into how chemical reactions — both homogeneous and heterogeneous—actually go.

The profession still needs a treatment of what might be called "Applied Chemical Kinetics"—the area lying between the more esoteric (to us) interests of the physical chemists and the direct design of reactors. For the process designer, however, the present book will be his most useful reference on kinetics and he will profit from the author's unusual combination of extensive experience in process design coupled with many years of teaching.

In Search of a Process

FREQUENCY RESPONSE FOR PROCESS CONTROL. By William I. Caldwell, Geraldine A. Coon and Leslie M. Zoss. McGraw-Hill

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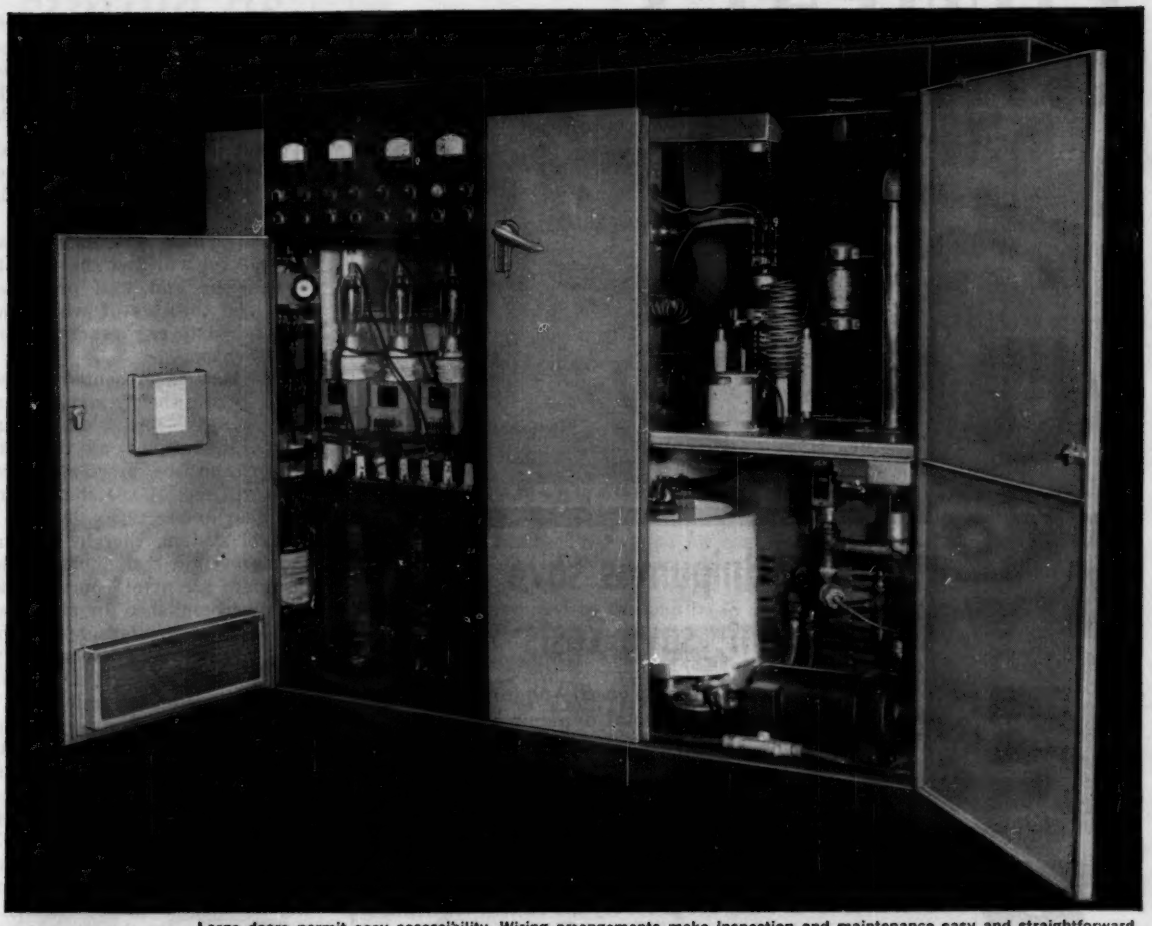

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Typical dielectric heater applications include: twist-setting rayon cord, jelling rubber, heating inert powders, preheating molding powders, and drying rayon.

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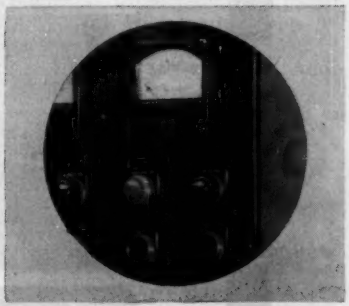

Eye-level controls give easy readability, accurate information on operating conditions. Controls are "grouped" together to give you a complete "picture" at a glance.

BOOKSHELF . . .

Book Co., Inc., New York. 390 pages. $11.50.

Reviewed by Charles R. Armstrong, Applied Physics Section, Manufacturing Department, Sun Oil Co., Newtown Square, Pa.

A once-through reading of this book, by experienced instrument men, will convince them that the art of process control is now a science. The newcomer in process control will find the book to be a clear and well presented text, the theories of which can be applied to any practical control problem.

The book is presented in two parts—basic theory and applications. In the first part, fundamental definitions of the controller and the process control loop will enable the instrument engineer to effectively describe a control system, thereby leading to more rigid techniques in the design of a control loop than has been accomplished in the past. The basic theory is complete and clearly presented. Some parts are so well covered that this reader tended to skip details.

The applications are quite interesting and easy to follow. An instrument without a process would be a useless tool; therefore this section of the book is very important.

Unfortunately, problems encountered in every-day engineering are not as easy to describe as those presented in this book. Somewhere along the line a reader should be made to realize that the process, not the instrument, is the most important part of a control loop. With this understanding, a student could then feel encouraged to peruse other literature for a solution to a particular problem, instead of depending only on the devices described in this book.

MORE NEW BOOKS

GAS PURIFICATION. By Arthur L. Kohl and Fred C. Riesenfeld. McGraw-Hill. $15.

PETROLEUM PRODUCTS HANDBOOK. Edited by Virgil B. Guthrie. McGraw-Hill. $18.50.

PLANT GROWTH SUBSTANCES. By L. J. Audus. Interscience. $10.

Hagan PowrMag Analog Computer Control

simple as

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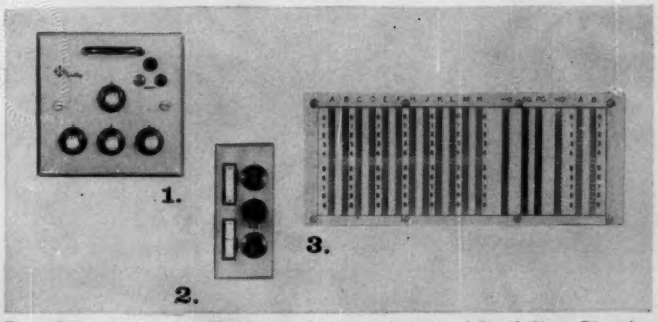

PowrMag systems embody the highest degree of flexibility. Simple, efficient electrical design utilizing long-lived and trouble-free solid state components, and rugged mechanical construction suit the system for a variety of industrial process control applications.

1. *Magnetic Control Unit*

This magnetic amplifier, operating on 1-9v DC, may be used individually, as a single 2 or 3 mode controller, or as one element in a large system. Each control unit may be removed from the front of the panel for easy interchangeability. The basic unit is easily converted to other modes by the addition of interchangeable, plug-in circuits for *all* common control operations. Inventory is reduced to the one basic unit. Unaffected by shock or vibration, PowrMag has no moisture, dirt, leakage or freezeup problems—3.5 watts of unregulated 110v, 60 cycle AC. Size—5¼" x 5¼".

2. *Remote Control Station*

These stations provide for remotely established set points and required manual control operations. Full station may contain two single or ganged potentiometers, one switch and two meters. Size—2¼" x 5¼". Half stations available with set point, bias or ratio dial and output signal indicator. Size—2¼" x 3⅛". Each station uses 12-wire, color-coded electric cable with MS-type connector. Front mounting and removal make it ideal for the compact console installations required for centralized control.

3. *Patchboard*

Interconnecting the system in any desired manner, via color-coded electrical cable, the patchboard requires no solder connections or terminal boards—all connections are made by special taper pins. Each connection is identified by an alphanumeric combination. Numbers, run vertically, identify the components in the system, such as magnetic amplifiers, controllers, transducers, etc. Letters, run horizontally, identify the connectors leading into the patchboard. DC control power bus is in the center section—no AC voltages are used in the patchboard.

Easy front access permits simple changing of operations. Additional loops or components are readily added to the system.

A letter or phone call will bring you complete information on the PowrMag system. **Ask for Bulletin MSP-163.**

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HAGAN DIVISIONS: CALGON CO. — HALL LABORATORIES — BRUNER CORP.

LETTERS:

Con: BLS Salary Survey

Sir:

There are certain aspects of your article, "A New Yardstick for Measuring Your Pay" (Jan. 11, pp. 120-122), that deserve further discussion.

Presumably the basic reason for the expanded Community Wage Surveys of the Bureau of Labor Statistics is to equip the Federal Government with data to assist in re-evaluation of its pay structure. The objective of revising government salaries of engineers—as well as other white-collar workers—to correspond more closely with those prevailing in other employment areas is certainly long overdue.

However, there is no clear-cut relationship between this need and the expanded survey. The government has available considerable data from many sources on which to base salary schedule revisions. The fact that substantial changes in salaries of government-employed engineers have not been made indicates government's inability to make the necessary adjustments, rather than absence of necessary information.

The distressing fact is that decisions concerning the program were apparently reached without any consideration of non-government organizations and activities, such as the EJC salary surveys. As far as we know, no opportunity was provided for a discussion of government needs and how these might be accommodated by existing studies or on any aspect of cooperative efforts between government and private agencies.

Thus a massive and costly survey will be superimposed on existing programs without consultation or notice. Employers are asked to contribute more of their time and effort to provide information to suit the government, and the taxpayer is asked to pay the bill.

L. K. WHEELOCK
Engineers Joint Council
New York, N. Y.

PRO & CON

C. H. CHILTON

Restrictions on Wood

Sir:

This is in reference to your article on "noncombustible" wood (Nov. 16, pp. 216-220).

The comments in the article are not wholly correct. We consider properly impregnated lumber which has been tested and approved by Factory Mutual Laboratories as a material of low combustibility. As such it enjoys recognition for limited applications on a par with the recognition accorded noncombustible construction.

However, there are certain restrictions. We would call attention particularly to the limit of 10,000 to 20,000 sq. ft. which has been established for roof-deck construction where supporting members have no greater combustibility than the deck itself and where the occupancy is noncombustible and unlikely to change.

Even in other applications where fire-retardant treated lumber is considered acceptable, the occupancy, in particular the absence of combustibles in the occupancy, is an important consideration.

W. H. McPHERSON
Factory Mutual Eng. Div.
Norwood, Mass.

Add: Isotope Supplier

Sir:

U. S. Nuclear Corp. seems inadvertently to have been omitted from your list of companies supplying radioisotopes (Nov. 16, 1959, p. 104).

We can supply Co-60, H-3, Kr-85, I-131, Cs-137, Pm-147, C-14 and Sr-90 in many different forms (gases, solutions, capsules, etc.). Typical prices are: $20/curie for H-3 gas, $2.25/millicurie for I-131 solution and $25/curie for standardized sources of Sr-90.

ALLEN M. GOLDSTEIN
U. S. Nuclear Corp.
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1	15-18l	37	59	91	106E	113-14f	140	200	206g	215	226E	L230a	237b	L243					
2	15-18m	38-39	60	93	107	113-14g	141	201	206h	216	226F	L230b	237A	R243					
4	15-18n	40	61	95a	108A	116	142	202	206i	217	226G	230A	237B	243A					
6-7	15-18o	41	62	95b	108B	117	165	202A	206j	218	226H	230B	237C	243B					
8-9	15-18p	42	63	97	108C	118	171	202B	206k	219	227	230C	238	243C					
10-11	15-18q	43	65	99	109	119	175	203	206l	220	227A	230D	TL239	243D					
12	15-18r	44	66	101	110A	120	177	203A	206A	224	227B	L231	BL239	243E					
13	19	45	67	102A	110B	121	179	203B	207	224A	227C	R231	R239	T250					
14	20-21	46	68	102B	110C	122	183	204	208	224B	227D	231A	240	B250					
15-18a	22-23	47	69	102C	110D	123	185	204A	208A	224C	228	232	240A	T251					
15-18b	24-25a	48	70	103	111	124	187	205	208B	225	228A	232A	TL241	B251					
15-18c	24-25b	49	71	104A	112A	125	191	205A	208B	225	228A	232A	TL241	B251					
15-18d	26-27	50	72	104B	112B	126	192	205B	210	225B	228C	234	R241b	TR252					
15-18e	28-29	51	74	104C	112C	127	193	206a	210A	225C	229a	234A	R241c	BR252					
15-18f	30-31a	52	76-77	104D	112D	128	194	206b	210B	226	229b	234B	R241d	253					
15-18g	30-31b	53	79	105	113-14a	129	195	206c	211	226A	229c	235	R241e	254					
15-18h	30-31c	54-55	81	106A	113-14b	130	196	206d	212	226B	229A	236	R241f	255					
15-18i	30-31d	56	85	106B	113-14c	133	197	206e	213	226C	229B	236A	L242	256					
15-18j	32	57	87	106C	113-14d	138	198												

A B C D E F G H J K L M N O P Q R S T U V W X Y Z

REPRINTS: Circle what you want. (See opposite page for description.)

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TECHNICAL

Content of This Issue

Chemicals

Acetone.....Specifications, properties, shipping information & uses for acetone are listed in a new data sheet now available. Material is employed widely as a solvent.
113-114f *U. S. Industrial Chemicals

Acrylonitrile.....A second, enlarged edition of the definitive "Chemistry of Acrylonitrile" is available. Includes new applications in plastics & surface coatings, etc.
24-25b *American Cyanamid Co.

Aluminus.....New KA-101 Active Aluminus for the Petroleum & Chemical industries. New technical brochure gives complete information on new special alumina products.
225 *Kaiser Chemicals Div.

Binder Resins.....Bulletin on wood particle binder resins indicates possible uses of melamine urea and resins in wood flour molding and in electrical parts fabrication.
224A American Cyanamid Co.

Boron Trifluoride.....Technical data on the properties and typical uses of B&A Boron Trifluoride gas or any of its complexes listed. Available now.
81 *Allied Chem., Gen. Chem. Div.

Chemicals.....Data sheet sheds new light on the reactivity of Triallyl Cyanurate & Daillylmelamine. Includes typical copolymerization & prepolymerization techniques.
24-25a *American Cyanamid Co.

Chemicals.....Brochure describes products and services; covers reorganization of three sister firms. Lists 46 chemical and metallurgical products for manufacturing.
224B Vitro Corp. of America

Chlroine Sources.....Chlorinated cyanuric acids and salts for compounding of bleaching and sanitizing products are described in 44-page technical bulletin.
224C Monsanto Chemical Co.

*From advertisement, this issue

LITERATURE

E. M. FLYNN

Citric Acid.....is water soluble, easy to handle, & non-toxic. Tech. Bul. 102 contains information about the use of Citric Acid for cleaning stainless steel equipment.
103 *Chas. Pfizer & Co., Inc.

Coatings.....Engineering data sheet describes Nicrocoat process for oxidation, corrosion and abrasion resistance. Discusses physical, chemical and fabrication properties.
225A Wall Colmonoy Corp.

Diatomite.....Each grade of Celite diatomite has its own distinctive particle size distribution. Assistance with specific filtration or mineral problems is available.
128 *Johns-Manville

Dispersants.....The Marasperses keep small particles of insoluble solids dispersed. Only a litte Marasperse is required to achieve a stabilized dispersion. File E-30.
208 *Marathon Div. of American Can

DL-Methionine.....Patients with chronic peptic ulcer were treated orally with the essential sulfur amino acid. DL-Methionine (3-6 grams/day) with good results.
113-114b *U. S. Industrial Chemicals

Elastomer.....Hypalon is resistant to corrosive chemicals, abrasion, ozone, sunlight, weather, etc. Additional information & subscription to Elastomers Notebook.
127 .E. I. du Pont de Nemours & Co.

Epoxy Resins.....Three new epoxy resins that display novel structure, reactivity and curing characteristics described in booklet that tells how these resins are different.
225B FMC Chemical & Plastics Div.

Ethyl Alcohol.....supplier U.S.I. has been operating vinegar test generators since 1932; helps customer with problems, studies production variables, keeps industry informed.
113-114a *U. S. Industrial Chemicals

Flameproof Paints.....Pamphlet describes use of chlorinated rubber with resultant film tough and hard enough to hold the total load of fire-fighting pigments.
225C Hercules Powder Co.

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LITERATURE . . .

Fluorcarbon Resins.....Teflon TFE resins are rated for continuous duty up to 500 F. Engineering data & further applications that may suggest uses in your processes offered.
105 *E. I. du Pont de Nemours & Co.

Fluorine.....A new fluorine booklet, "Handling Fluorine and Fluorine Compounds," goes into detail on fluorine corrosion, & suggests means of overcoming it.
32 *International Nickel Co.

Fungicides and Bactericides.....Pamphlet describes problems in prevention of bacteria, fungi and mildew attacks. Includes information on mildewcide-preservative for paints.
226A Metalsalts Corp.

Furfuryl Alcohol Resins.....are infusible, insoluble polymers when cured. Have low porosity. Information about uses, physical data & chemistry in Bulletin 205.
97 *The Quaker Oats Co.

Halogenation Review.....Bound reprints of series of reviews based on fluorine, chlorine, bromine and iodine by Dr. E. T. McBee, Chemistry Dept. of Purdue University.
226B Columbia-Southern Chem. Corp.

Heavy Chemicals.....Per capita consumption of Clorine, caustic soda, sulfuric acid, and ammonia has been growing steadily since 1939. Statistics have been assembled.
113-114c *U. S. Industrial Chemicals

Indium.....Bulletin HP-106 describes three grades of high purity indium ingot covering a purity range from 99.9% to 99.999%. Includes various suggested applications.
226C High Purity Metals, Inc.

Magnesium Oxide.....Only MgO produced by thermal decomposition. High resistivity and refractory properties at relatively low cost. Details available.
37 *International Minerals & Chemical

Pharmaceuticals.....1960 catalog and price list of biochemicals and radiochemicals. Includes atomic weights, buffer tables, filter selection of colorimetry.
226D Subet Laboratories, Inc.

Plastics Packaging Suppliers.....36-page directory lists in alphabetical order custom and proprietary plastic packaging molders and extruders in the United States.
226E Koppers Co., Inc.

Polyethylene.....production in 1959 estimated at over a billion pounds. The one billion pound mark was passsed by two materials, polyethylene and vinyl.
113-114d *U. S. Industrial Chemicals

Polyethylene Printing.....Well detailed booklet gives extensive information on treating of and printing on polyethylene. Seven schematic diagrams illustrate methods.
226F U. S. Industrial Chemicals Co.

Polypropylene Polymer.....Data folder on heat resistant, tough material with low specific gravity characteristics includes detailed information on properties and uses.
226G AviSun Corp.

Protective Coatings.....Brochure describes number of protective maintenance coating system; matches them with application problems. Includes data on 69 reagents.
226H The Glidden Co.

*From advertisement, this issue

Refrigerant.....CO_2 for refrigeration is available as dry ice approx. 275 BTU/lb. and as liquid @ O F. approx. 130 BTU/lb. Additional information on request.
253 *Olin Mathieson

Silica Aerogel.....Amazingly low thermal conductivity of Santocel A discussed in bulletin that contains product descriptions of chemical, structural and physical properties.
227A Monsanto Chemical Co.

Sodium Reduction Process.....A new route to thorium which yields the metal at 99.8% purity, with an oxygen content of 200-500 ppm. has been developed.
113-114e *U. S. Industrial Chemicals

Sodium Borohydride.....is easily used with complete safety in standard equipment. It is shipped in polyethylene-lined, 55-gal. drums. Complete information.
101 *Metal Hydrides Inc.

Solvent.....Methyl ethyl ketones strong solvency for lacquer resins has made it a favorite with formulators. Technical assistance & more information on request.
Cover *Shell Chemical Co.

Surface Active Agents.....24-page catalog describes each product by trade name, active ingredient, percent activity, physical state, specific applications and properties.
227B Onyx Oil & Chemical Co.

Urea, Biuret Formation from.....Results of a recent study undertaken to help fertilizer formulators control the presence of this harmful chemical are available.
113-114g *U. S. Industrial Chemicals

Urethane.....Brochure contains charts showing physical properties, applications and advantages of Daycollan, a cast of solid urethane that may be molded or machine finished.
227C The Dayton Rubber Co.

Construction Materials

Aluminum Bronze Alloys.....Bulletin describes physical and chemical properties of 9 major grades. Metal shows high resistance and is nonmagnetic.
227D Ampco Metal Inc.

Carbide Nozzles.....are designed in a broad range of shapes & sizes, for varying applications. Booklet B-111-A, "Properties of Kennametal" is offered.
234 *Kennametal Inc.

Ductile Iron.....Manual describes how you can get steel strength in regulators & control valves. Shows how ductile iron is produced, shows features, specifications, etc.
BR252 *OPW-Jordan

Iron Oxide Pigments.....Research and development facilities to help you with the problems of proper pigmentation. Assistance available on request.
201 *C. K. Williams & Co.

Packings.....Lattice-Braid teflon packings are strong, long-lasting, chemically inert. Withstand temperatures ranging from −120 F to +500 F. Catalog AD-131.
30-31a *The Garlock Packing Co.

*From advertisement, this issue

LITERATURE . . .

Rupture Disc.....The CPV unit sizes range from 1" to 24" with rupture pressure ranging from 4 to 850 lbs. PSIG at 72 F. New complete catalog is offered.
R199 *Fike Metal Products Corp.

Screens.....The new Conidure and Rima screens offer a new concept in screening. Illustrated catalog contains complete information on both.
91 *National-Standard Company

Stainless Steel.....Two booklets, "How Armco Stainless Steels Serve the Petrochemical Industry" and "How Armco Stainless Steels Improve Pulp, Paper & Profit" offered.
46 *Armco Steel Corp.

Stainless Steel Wire.....Illustrated 20-page booklet fully describes analyses, physical properties, corrosion resistance & principal application of stainless wire.
70 *Allegheny Ludlum Steel Corp.

Electrical & Mechanical

Automatic Valve Controls.....Electrodyne is a valve type-control for a wide variety of applications in chemical & power plants, oil & gas industries, etc. Details.
194 *Hupp Aviation Div.

Drive.....Ajusto-Spede drive is the answer to precise operating speeds for machine tools, process machinery, test equipment, windups, etc. Bulletins 2750 & 2800.
50 *The Louis Allis Co.

Drive Turbine.....Bulletin describes single stage, mechanical drive turbine, centerlinemounted to minimize shaft misalignment due to thermal expansion.
228A Dean Hill Corp.

Electric Power, Emergency.....Folder outlines steps in selection of emergency generating plant, errors to avoid, "musts" to consider. Lists items to evaluate for any need.
228B D. W. Onan & Sons Inc.

Electronic Components.....Comprehensive drawings, illustrations and tables of plastic components given in catalog. Includes drawings of stand-off; feed through insulators.
228C Garlock Electronic Products

Expansion Joints.....Catalog AD-137 contains complete information on solid teflon and teflon-lined expansion joints for the chemical processing applications.
30-31d *The Garlock Packing Co.

Gaskets, Teflon-jacketed.....in 4 basic designs; slit envelope, milled envelope, formed shield, double jacket & a wide selection of filler materials & thicknesses. Cat. AD-154.
30-31c *The Garlock Packing Co.

Lighting Fixtures.....Series EV explosion-proof fixtures are easy to install & relamp. Available in choice of mountings, with a variety of reflectors.
74 *Crouse-Hinds Co.

Lighting Fixtures.....Details on mercury vapor explosion-proof fixtures for hazardous areas, as well as a full complement of accessories including mountings, reflectors, etc.
1 *Appleton Electric Co.

*From advertisement, this issue

Mechanical Seals.....Chemiseal mechanical seals are available in standard sizes to fit all pump shafts ⅞" to 2⅛" shaft. Details in Catalog AD-164.
30-31b *The Garlock Packing Co.

Motors, Electric.....New L. A. line are described in detail in Bulletin #1701. Important features inside & out plus bearing construction & lubrication are covered.
229A The Louis Allis Co.

Rectifier Units.....4-page pamphlet describes oil-filled silicon rectifier conversion units for electrostatic precipitator and other types of high-voltage power supplies.
229B General Electric Co.

Swivel Joints.....The DS series with interchangeable packing feature can handle a wide range of chemicals in services from —65 to +400 F at 300 PSI. Bulletin 1258.
71 *Chiksan Company

Transformers, D. C. Current.....Type IG 40 are unaffected by dirt, corrosive gases, temp. influences, stray fields, voltage & frequency variations in the secondary.
67 *Allgemeine Elektricitats

Turbines.....YR turbines are designed for easy installation & service. Many key parts are interchangeable for various frame sizes. Descriptive bulletin H22-C is offered.
63 *Elliott Company

Variable Speed.....The new "400 Series" offers lever, screw, vernier or remote control. Over 250 fractional horsepower models & types. Catalog.
TL239 *The Zero-Max Co.

Volt Starter.....Complete details on the EC & M 2200-4800 volt starters contained in Bulletin 8210. They feature fully automatic synchronization.
79 *Square D Company

Handling & Packaging

Belt Conveyor.....for your bulk material handling problems. Two new series of heavy duty belt conveyor idlers have design improvements. New bulletin gives details.
6-7 *Barber-Greene

Belt Weigher.....Pneu-Weigh offers high accuracies, wide ranges, capacities in compact uncomplicated unit. Complete details in Bulletin 36.20-1.
227 *B-I-F Industries, Inc.

Conveyor.....Airslide Fluidizing Conveyor fluidizes dry, pulverized materials with low pressure air. Take up little space, can be used singly & in combination.
56 *Fuller Co.

Conveyors.....Detailed descriptive matter, charts and illustrations given in 22-page bulletin No. 112 makes it possible to order from pre-engineered standards in stock.
229C Standard Conveyor Co.

Dumpmaster Hauler.....Brochure describes the service of the Dempster-Dumpmaster equipped hauler in detail. Provides containers & service for small fee.
60 *Dempster Brothers

* From advertisement, this issue

LITERATURE . . .

Enclosed Countershaft Ends.....available for 6" to 20" diameter screw conveyors, in 1:1 & 2:1 ratios, & in all shaft combinations. Bulletin contains complete specifications
R231 *Southwestern Supply & Machine

Flip Cap.....The new all-purpose plastic Flip Cap is permanently hinged to its dripless pour spout. Top of container can be fully lithographed.
197 *Continental Can Co.

Fork Trucks.....4-page folder illustrates three explosion-proof battery powered trucks for use in hazardous locations. Dimensional data and specifications given.
230B Clark Equipment Co.

Magnetic Pulleys.....Complete line in 2 "duty-rated" designs. New fact-filled 6-page bulletin has installation photos, selector guide, etc. Available now.
230C Eriez Mfg. Co.

Pneumatic Bulk Truck.....Bulletin 205-A shows how these bulk trucks are cutting handling and delivery costs in a variety of industries. Copies on request.
237a *Sprout, Waldron & Co., Inc.

Pneumatic Systems.....are helping industry cut costs & speed transfer of all types of material. Get the facts in a copy of Bulletins 18-F and 208-A.
237b *Sprout, Waldron & Co., Inc.

Screw Conveyors.....and a wide range of components for screw conveyor applications. Also a new line of ball & roller bearing equipped accessories. Book 2989.
41 *Link-Belt Co.

Tractor Shovels.....The model 12B capacity is 3,000 lbs. buckets are available to carry from 6 to 27 cubic feet. Details available upon your request.
121 *Clark Equipment Co.

Heating & Cooling

Boilers.....4-page catalog lists advantages of new light oil, gas and combination fired packaged boiler. Section devoted to explanation of safety features.
230D Cleaver-Brooks Co.

Dielectric Heaters.....Typical applications include: twist-setting rayon cord, jelling rubber, heating inert powders, preheating molding powders, & drying rayon. Details.
215 *Allis-Chalmers

Dryers.....Conical Rotating Vacuum Dryers are available in six standard sizes with working capacity ranging from 3 to 150 cu. ft. Special units for unusual requirements.
66 *F. J. Stokes Corp.

Dryers, Desiccant.....are designed to dry air & gases under pressure (ranging from 1000 to 6000 psig) to dew points of —160 F. Full details in Bulletins D-108 & D-109.
f11 *The C. M. Kemp Mfg. Co.

Equipment.....Bul. E-1 shows designs in heat exchangers, reactors, oil chillers, crystallizers, pressure vessels, steam generators & ice making & refrigerating machinery.
142 *Henry Vogt Machine Co.

*From advertisement, this issue

LITERATURE . . .

Evaporators.....Used for all chemicals—acids, salts, pharmaceuticals, recovery of industrial waste. Right evaporator can be job-tailored for your product. Cat. 372.
200 *Blaw-Knox

Gages, Liquid Level.....Reflex for pressures up to 4000 lbs. @ 100 F. Transparent for pressures up to 20,000 psi test. Choice of materials. Catalog No. 335.
L242 *Jerguson Gage Valve Co.

Heat Exchanger.....Aero Heat Exchanger is a self-contained fluid cooling system. It offers accurate temperature control. Bulletin No. 132 is available.
B250 *Niagara Blower Company

Heat Exchangers.....Transaire Air-Cooled units are now being used in many varied processing operations. Feature the exclusive Aimco fin-tube.
65 *Yuba Consolidated Industries

Heater.....Hi-Turbiant has two broad fields of application; heating transfer fluids & direct firing. Bulletin HT-100 gives detailed data & shows typical system.
133 *Western Precipitation Corp.

Heating & Cooling.....Beth-Tec systems offer a heating capacity of 50,000 Btu's/hr., a cooling capacity of 100,000 Btu's/hr., & temperature range up 900 F. Brochure 400.
R242 *Bethlehem Foundry & Mach. Co.

Ovens.....Bench, Cabinet, Truck, and Conveyor types. Bulletin 127 describes the many types of ovens available for specific heat processing operations.
L252 *W. S. Rockwell Co.

Panelcoil.....now available in 26" and 29" width in all standard lengths up to 143". Dean Data Sheet 15-60 series and Price Bulletin 259 are offered.
TR252 *Dean Products, Inc.

Plate Heat Exchanger.....Bulletin E-1153 covers capacities, applications and construction of Crescent heat exchangers for heating, cooling & pasteurizing.
231A The Creamery Package Mfg. Co.

Rotary Coolers.....in four types; Gas-Cooled, Water-Cooled Shell, Tubular type, and Direct-Contact Water. Further information is available on request.
236 *Hardinge Co.

Steam Traps.....Thermo-Dynamic TD-50's never block heat transfer & they remove condensate & air as fast as they collect. Information on Tracer Line Trapping.
198 *Sarco Company, Inc.

Instruments & Controls

Analog Computer Control.....Powr-Mag systems embodies Magnetic Control Unit, Remote Control Station and Patchboard. Complete information in Bulletin MSP-163.
217 *Hagen Chemicals & Controls, Inc.

Autrometer.....Complete technical information including performance curves on a wide variety of materials is available on your written request.
123 *Philips Electronics Instruments

*From advertisement, this issue

LITERATURE . . .

Chromatograph, Industrial Gas..... Detailed instrument specifications and answers to your process control problems are contained in data file 14-13-07.
191 *Beckman Instruments, Inc.

Computer.....The new IBM 7080 transistorized data processing system offers a choice of 40,000, 80,000 or 160,000 characters of magnetic core storage.
99 *International Business Machines

Control Units.....Standard duty, heavy duty, & oiltight have double break, silver alloy contacts to assure reliable operation. Publication 6090 offered.
122 *Allen-Bradley Co.

Controls.....The complete design data on all sizes of standard flexible shafts, geared joints and terminals is contained in Design Manual 5811. Send for your copy.
205 *Stow Manufacturing Co.

Controller.....One basic 53P controller accepts pneumatic or mechanical inputs. You'll find any number of reasons for the success of the 53P in Catalog 53P-4000.
130 *Fischer & Porter Co.

Flowmeter.....Gyro-Integrating true mass flowmeter accurately measures flow of liquids, gases & liquefied gases . . . directly in pounds. Bul. GEA-6925A, Section 599-02.
8-9 *General Electric Co.

Gas Meter.....The new rotary gas meter is only 14" long, mounts in the line. Accurate to 300 cfh and up to 125 psi. Complete data is available.
175 *Roots-Connersville Blower

Gauge.....The Liquidometer Tank Gauge measures virtually any liquid, is simple to install & requires no maintenance. Complete information on request.
218 *The Liquidometer Corp.

Gauges.....You can pick from over 50,000 standard USG indicating dial pressure gauges . . . and thousands more in specials. Catalogs & names of distributors available.
118 *United States Gauge

Gauges and Instruments.....Pamphlet features pressure and vacuum gauges indicating pneumatic controllers and transmitters. Details and technical data included.
232A Amer. Machine & Metals, Inc.

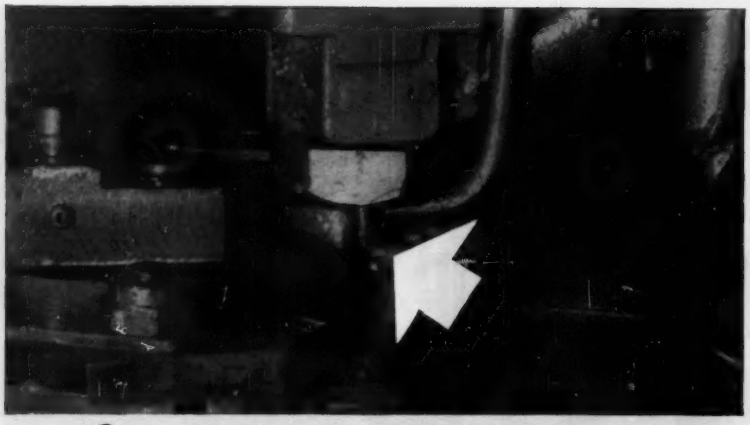
Instrument.....Bul. 13-23 fully illustrates & describes the Type 14A Pneumatic Integrator, & points the way to economical accounting of pocess & plant service flows.
179 *The Foxboro Co.

Meters.....Inline electronic turbine type meters offer capacities from 0.1 GPM to 40,000 GPM. Information on this type plus Xacto Meters & Proportioneers in Catalog.
47 *Bowser, Inc.

Process Refractometer.....Instrument literature on the new M-S-A Process Refractometer or any of the other process stream analyzers is available on request.
54-55 *Mine Saftey Appliances Co.

Scales.....Printweigh Scales in a wide range of models; Portable, Floor & Bench types, Built-in, Hopper, Overhead Track and Motor Truck types. Bul. 2017.
220 *Toledo Scale Corp.

*From advertisement, this issue



Machines equipped with the new Kennametal hard carbide nozzles spray sealing material on can lids—at 90% saving in nozzle cost.

KENNAMETAL* Carbide Nozzles outlast stainless steel nozzles by 18 to 1

When a manufacturer of cans replaced stainless steel nozzles with Kennametal tungsten carbide nozzles in machines applying a sealing compound to the metal can lids, they gained these substantial advantages:

ONE — Kennametal carbide nozzles ran 5,328 hours with no apparent wear or change in the size of the orifice. Stainless steel nozzles on the same application lasted an average of only 296 hours.

TWO — Initial cost of Kennametal carbide nozzles was more than double the cost of stainless steel nozzles. But nozzle cost was reduced 90 per cent—because the Kennametal nozzles had an 18 to 1 longer life than the stainless steel nozzles.

THREE — Kennametal carbide nozzles permitted a pressure increase from 55 to 105 psi—which resulted in more uniform coverage, improved quality and fewer rejects of cans due to sealing.

There is a good chance that Kennametal hard carbide compositions can help you solve a problem which involves corrosion, abrasion, erosion or contamination. Our group of hard carbides includes grades that last up to 60 times as long as steel—grades that are three times as rigid as steel—and grades that retain normal properties under prolonged exposures up to 2200°F (at even higher temperatures for shorter periods) and at sub-zero temperatures.

We would like you to know more about Kennametal and how it has helped others solve problems that may be similar to yours. Write to Kennametal Inc., Dept. CE, Latrobe, Pennsylvania. Ask for Booklet B-111-A, "Properties of Kennametal."

*Trademark 97263

Kennametal nozzles are designed in a broad range of shapes and sizes for varying applications.

INDUSTRY AND KENNAMETAL

...Partners in Progress

LITERATURE . . .

Control Temperature.....Leaflet details transmitter and receiver equipment for remote temperature control used for heating-cooling air conditioning.
234A Powers Regulator Co.

Thermometers.....American Bi-Metal thermometers are made of weatherproof stainless steel. The two-level "Maxivision" dial eliminates parallax effects. Catalog 100A.
42 *Manning, Maxwell & Moore, Inc.

Pipe, Fittings, Valves

Cylinder.....Catalog sectionalized by products covers air and hydraulic cylinders, piston rods, cushions, bosters, etc. Mounting and dimensional data included.
234B Flick-Reedy Corp.

Expansion Joints.....Fluoroflex-T expansion joints molded from Teflon offer long trouble-free life & excellent working pressure ratings. Facts in Bul. B-1A.
57 *Resistoflex Corp.

Fittings.....Forged Steel Fittings give you the added resistance to pressure, heat, corrosion, shock, & vibration. Specifications & Distributor locations on request.
203 *H. K. Porter Co., Inc.

Hose.....Acid discharge hose remains flexible even when cold and is highly resistant to weathering. Hose ends are rubber sealed. Further information on request.
69 *Acme Hamilton Mfg. Corp.

Industrial Piping System.....Information on products for any industrial piping system including copper tube & fittings, PVC rigid pipe & fittings, & valves of all types.
224 *Mueller Brass Co.

Pipe.....Saran lined pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200 F. Information.
138 *Saran Lined Pipe Co.

Pipe.....All purpose rigid PVC in schedules 40, 80, & 120, ½ to 4". Threaded or socket-weld fittings. Valves ½ 2". Further information in Bul. CE-56.
229b *American Hard Rubber Co.

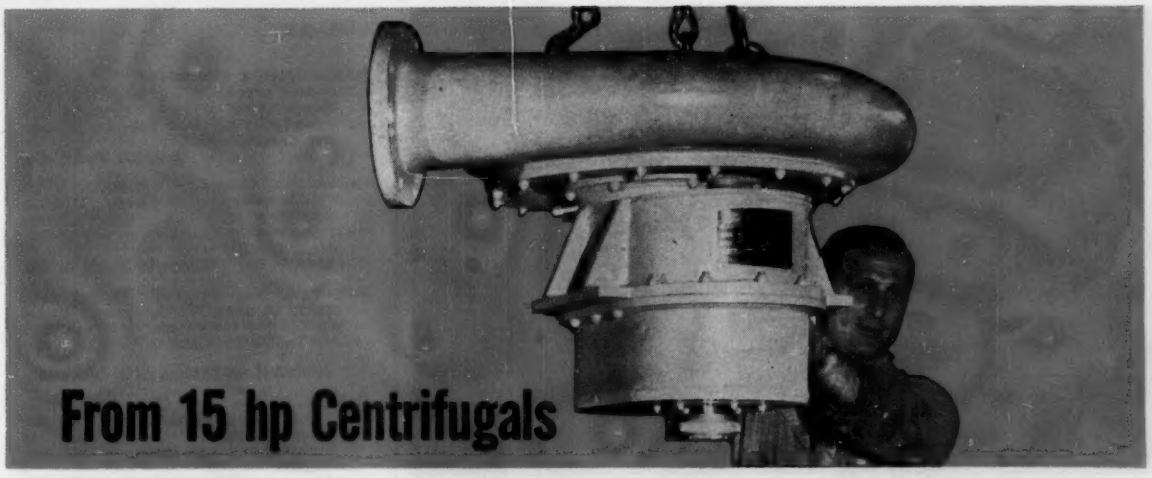
Pipe, Plastic.....Flexible poly pipe is ideal for water lines, drains, underground pipe or conduit. In sizes ½ to 2", long coils. Details in Bul. CE-57.
229c *American Hard Rubber Co.

Pipe, Pyrex.....Complete information about Pyrex Pipe as well as a complete line of Pyrex brand heat exchangers and laboratory drainlines & fittings.
38-39 *Corning Glass Works.

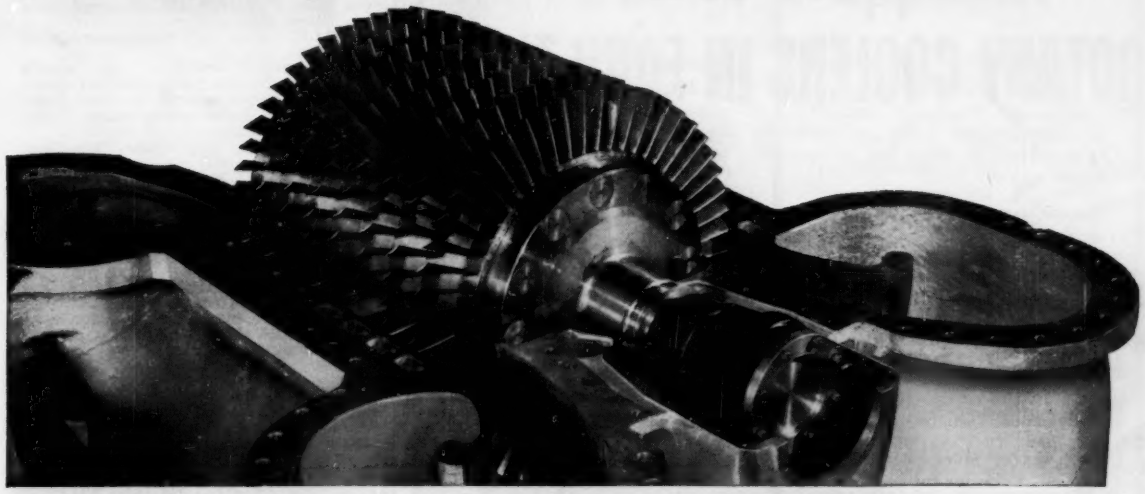
Piping.....A new 24-page bulletin contains complete information about piping assemblies and other mechanical equipment. Send for your copy.
51 *Midwest Piping Co., Inc.

Piping.....UPVC piping does not have to be painted & stops piping corrosion & galvanic action. Bul. 119 describes the complete lines of UPVC fittings, flanges, valves, etc.
BL241 *Tube Turns Plastics, Inc.

*From advertisement, this issue



to 15,000 hp Axials . . .



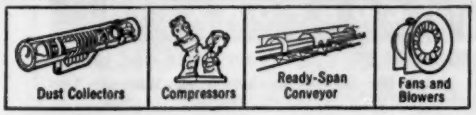
JOY CAN SUPPLY THE COMPRESSORS YOU NEED

Joy can supply a compressor with the exact performance characteristics and physical configuration to meet your requirements, no matter how large or how small. Standard models are available, or Joy Turbodynamics engineers can design to your specifications in any size of compressor—either centrifugal or axial-flow types.

Compactness and efficiency are achieved in all Joy dynamic compressors through high stage performance. Advanced aerodynamic concepts and modern metallurgy have contributed to designs which provide the maximum of compressed air or gas for power consumed and floor space occupied.

Joy Axial-flow and Centrifugal Compressors will prove the most economical solution, whether you are compressing plant air, or process air or gas, at normal or elevated pressures and temperatures. If you have an air or gas compressing problem, check with your Joy representative or write for our bulletin "Joy Turbodynamics."

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

LITERATURE . . .

Pumps, High Temperature.....are designed especially for handling high temperature liquids. Feature hydraulically efficient impeller & casing design. Facts.
165 *Buffalo Forge Co.

Unions.....Complete information on "Hi-Pressure" Handlebar Unions. Available in 2" size, these unions have wide application in the petroleum industry.
87 *Clayton Mark & Co.

Valve.....New Pressure Sealing gate value is designed for pressures up to 720 psi (cwp) and temperatures up to 250 F. Catalog 1200 is available.
44 *W-K-M Div. of ACF Industries

Valve.....The ¾" (Fig. 802) Self-Closing Ball Valve is designed for smooth, leakproof handling of highly flammable liquids. Complete details.
129 *Rockwood Sprinkler Co.

Valve, Flow.....All-Neoprene-Stainless solids flow valves for blending, milling, conveying applications. Sizes 6" 8", 10", 12". Product Data Sheet 18V.
TL241 *Patterson-Kelley

Valve, Safety-Relief.....is ideally suited for both pressure & vacuum relief. Seals against liquids & gases. Pyrex & Teflon construction. Bulletin RV-1.
L230a *Chem Flow Corp.

Valves.....Aloyco Stainless Steel Valves are now available in sizes up to 24", pressures up to 2,500 lbs. at 650 F. New test facilities and research.
183 *Alloy Steel Products Co.

Valves.....for handling water, oil, gas, air, steam, corrosive fluids, or fuels. Complete information available on Powell Valves in the U. S. Missile program.
93 *The Wm. Powell Company

Valves.....The V-10 regulating valve with type J-1 positioner is designed for rugged high-pressure liquid or steam service. Additional information on request.
120 *Republic Flow Meters Co.

Valves.....8-page booklet details design and selection factors, function, application and method of actuation of valves for fluid flow and condition control.
236A United Aircraft Products, Inc.

Valves, Butterfly.....that's bubble-tight at 500 psi. Handles temperatures from 60 F. to +450 F. For 60 degree throttling or 90 Degree on & off. Literature.
B251 *Fisher Governor Co.

Valves, Diaphragm.....are available in a wide range of body, lining and diaphragm materials. Further details are available to you on request.
124 *Grinnell Company

Valves, Gate.....Information Folder No. 205 describes the Ni-Resist Gate Valves. "Ni-Resist" extends the valve life in corrosive and erosive services.
109 *Jenkins Bros.

Valves, Pinch.....for corrosive & abrasive pulps & liquids. Pressures to 160 psi, temperatures to 200 F. Catalog gives complete data & list of recommended applications.
212 *The Mine & Smelter Supply Co.

* From advertisement, this issue

LITERATURE . . .

Valves, Plastic.....for liquid and gas transferring operations are available in 5 plastic materials & an extensive size range. Catalog contains recommendations.
196 *Chemtrol

Valves, Safety Relief.....have a special "O" Ring Seat Seal that stops leakage completely. Available in both Standard & Balanced Bellows design. Bulletin 1940.
12 *Manning, Maxwell & Moore, Inc.

Valves, Vacuum.....Data sheet presents new approach to compact design in air-operated vacuum gate valves. Includes drawings, installation data.
237A Vacuum Research Co.

Process Equipment

Agitators & Mixers.....Turbine-type propeller (to 120" in tanks to 50' dia.), slow speed, high speed, air lift, vertical turbine mixers, mixer-settler units. Bul. A2-B2.
206a *Denver Equip. Co.

Attrition Scrubbers.....High power input to efficiently remove sand coatings, mix dense slurries. Rubber lined or acid-proof tanks. Sizes to 56" x 56". Bul. A-8505.
206b *Denver Equip. Co.

Ball & Rod Mills.....offer operation & convertibility. Wet or dry grinding systems. Sizes to 10' x 20'. All steel construction. Bulletin B2-B20.
206c *Denver Equip. Co.

Centrifugal.....Schematics and specifications on 40-inch universal centrifugal, developed for internal pressures to 150 psi. Drum speeds, capacity and horsepower given.
237B Baker Perkins, Inc.

Centrifuge.....The Fletcher Tornado-Matic is available in 5 sizes, from 6 to 16 cubic feet capacities. Features exclusive control system & contamination-free unloader.
61 *The Sharples Corp., Fletcher Div.

Compacting System.....is a package of integrated equipment; the new compacting mill, a roller mill & either a gyratory or vibrating screen. Details in Bul. 07B8836.
213 *Allis Chalmers

Conditioning and Drying Systems..... Brochure describes equipment used to stop condensation, speed drying, and other processing operations, and obtain sub-freezing dewpoints.
237C Surface Combustion Div.

Crushers.....Bulletin "How To Select a Crusher" describes the various kinds of mechanical reduction & the types of Pennsylvania crushers that supply each one.
95a *Bath Iron Works, Penn. Crusher

Crystallizers.....Details on the new DTB Crystallizers is now available. New booklet "Processing Profiles" contains additional information. Send for your copy.
177 *Swenson Evaporator Co.

Cyclones.....Complete new Uni-Circle Manifold available in stainless steel, can be vapor-proof. Cyclones from 1⅛"-36" diameters. Brochure 1157.
T251 *Heyl & Patterson, Inc.

*From advertisement, this issue

LITERATURE . . .

Demineralizers.....are available in mono-column, dual-column and multi-column types in flow rates from 10 to 10,000 G.P.H. Full catalog information on request.
R239 *Penfield Mfg. Co., Inc.

Drum Separators.....The Indox V drum separator is ideal for process industries where materials are conveyed in enclosed chutes & spouts. Details in Bulletin No. 1051 C.
228 *Stearns Magnetic Products

Dust Filter.....The new "RJ" is now available in 5 sizes for handling from 300 to 6400 CFM of air (for larger capacities, multiple groupings are furnished). Bul. G-30.
192 *The Day Co.

Filter.....The Rotary Drum Vacuum Filter offers high washing efficiency and fume tight construction. Complete pilot-scale test facilities are offered.
2 *Bird Machine Co.

Filters, Corrosion Resistant.....Permanent filter element offers maximum particle retention with very high flow rate. Porosity range, one to 100 microns. Bul. FPT-2.
L230b *Chem Flow Corp.

Filtration.....A complete line including filter presses, closing devices, and filter media. Information on complete technical service & filtration service in catalog.
117 *D. R. Sperry & Co.

Impact Mill.....dispersions are complete & uniform within the closest tolerances in both batch & continuous processing of dry materials and aqueous suspensions.
219 *Entoleter Inc.

Jaw Crusher.....The Kue-Ken employs the "crushing without rubbing" principle. Widely used for crushing a variety of materials in the chemical industries. Bul. 5012.
95b *Bath Iron Works, Penn. Crusher

Jaw Crushers.....Cast steel frame, anti-friction side bearings & bumper bearings. Sizes from 2¼" x 3½" to 36" x 48". Details in Bulletin C12-B12.
266d *Denver Equip. Co.

Micronizers.....grind & classify in one operation in a single chamber & provide fines in range from ½ to 44 microns. Eight models are available. Bul. No. 091.
L231 *Sturtevant Mill Co.

Mixer.....New model RL Hi-Shear offers uniform circulation-no vortex, & controllable flow pattern. Handles viscous materials with ease. All parts stainless steel. In-
214 *Gabb Special Products Inc.

Mixer.....New Series RE is available in a full range of sizes in your choice of 6 different mountings for open or closed tanks & in standard power-speed combinations.
256 *Mixing Equipment Co.

Mixer.....New brochure tells the complete story of the "Multi-action" Mixer. Ideal for today's heavy duty requirements. Bulletin 581 available on request.
49 *Struthers Wells Corp.

Mixers.....Handbook on Mulling describes controlled dispersion in simple terms, provides full details on 9 models of the Simpson Mix-Muller; how it is used, etc.
139 *Nat'l. Engineering Co.

*From advertisement, this issue

LITERATURE . . .

Mixers.....for agitating, mixing, reacting, suspending solids, blending miscible liquids, circulating, heat transfer and continuous treating. Bulletin 581.
43 *Nettco Corp.

Mixers, Pony.....A model for every need with single motion or twin motion mixing action, 1 or 2 speed motors, in working capacities from 3 to 125 gal. Bul. 500.
204 *The J. H. Day Co.

Pressure Filter.....The Vallez rotating leaf pressure filters were designed specifically for removing color & purifying corn syrup. Complete detailed information.
232 *Goslin-Birmingham Mfg. Co., Inc.

Process Equipment....."Sub-A" Flotation is available in sizes from 16" x 16" to 72" x 72". Three types: "Cell-to-Cell"; "Free-Flow"; Type "M". Bul. F10-B86.
206f *Denver Equip. Co.

Process Equipment.....Technical assistance plus a library of product information. Bulletins available on homogenizers, colloid mills, pressure exchange pumps, etc.
62 *Manton Gaulin

Reagent Feeders.....Both wet and dry feeders are available. Many standard units in stock. Complete information contained in Bulletin F6-B8. Send for your copy.
206e *Denver Equip. Co.

Rotary Airlock Feeders.....Complete information on Rotary Airlock Feeders for dust control and pneumatic conveying contained in Bulletin P 58.
BL239 *Prater Pulverizer Co.

Samplers.....Continuous mechanical & automatic types for dry, solution or slurry sampling. Complete sampling plants & sample processing equipment. Bul. S1-B4.
206j *Denver Equipment Co.

Screens.....Bul. S3-B15 covers Denver-Dillon Screens for efficient wet or dry screening. Sizes to 6' x 14' in stock. Trommel Screens in sizes 30" x 60" x 120".
206k *Denver Equip. Co.

Scrubber.....The type VO Oriclone is a new scrubber for ultra-efficient dust & fume control. For a wide range of industrial applications. Detailed information.
58 *The Ducon Company, Inc.

Spiral Rake Thickeners.....move settled materials to center in one revolution. Acid proof construction available. Further information in Bul T5-B6.
206l *Denver Equipment Co.

Spray Nozzles.....Over 12,000 standard spray nozzles for more exact performance to fit your needs. Complete information available in Catalog No. 24.
T250 *Spraying Systems Co.

Sludge Collectors.....28-page catalog lists line of six series and 15 types of collectors available for water, sewage and industrial waste treatment settling tanks.
240A Link-Belt Co.

Tower Cleaning.....Literature and details on any cleaning problem—towers, tanks, pumps, compressors, exchangers, lines, fittings, valves, etc.
210 *Oakite Products, Inc.

* From advertisement, this issue

ALL-NEOPRENE-STAINLESS P-K SOLIDS FLOW VALVE

AS LOW AS $96.00

Install this compact P-K valve for blending, milling, conveying applications – wherever powders or granulations require flow control. All parts, including neoprene liner, are interchangeable and easily replaceable in field. Precision machined.

Among accessories – air actuator, 90° rotation; adapter to fit P-K valve to existing equipment; plastic bag adapter; positive pressure of vacuum tight cover. Sizes 6", 8", 10", 12".

Send for Product Data Sheet 18V– today.

Patterson Kelley

Chemical and Process Equipment Div., East Stroudsburg, Penna.

Reduces piping costs ...stops corrosion

Plants, large and small, are switching to unplasticized polyvinyl chloride (UPVC) piping for corrosive services to make these important savings in first costs and in operating costs: UPVC piping materials cost substantially less than metals, alloys or lined material commonly used in the same services. It can be erected easily and quickly. Widely used socket type joint can be made in about a minute with solvent cement and a brush. UPVC piping is easy to handle...weighs less. It does not have to be painted. It stops piping corrosion and galvanic action.

The tlp* line of injection molded UPVC fittings, flanges, valves, solvent cement and thread lubricant is available nearby from your Tube Turns Plastics' Distributor. He can supply *all* your needs on one order and can help you with design and installation data. Write us for the complete line catalog, Bulletin 119. TUBE TURNS PLASTICS, INC., Dept. CE-3, 2929 Magazine Street, Louisville 11, Kentucky.

*"tlp" is a T. M. Reg. U. S. Pat. Off.

Handle Flammables SAFELY with Protectoseal PRODUCTS

STAINLESS DRUM FAUCETS

For 30 and 55 gal. drums. Self-positioning or rigid spouts. Self-closing. Stainless steel body. Teflon O-Ring Seal.

DRUM TRANSFER PUMP

For quick, safe dispensing from drums. Pumps up to 5 gpm. Optional cut-off control eliminates overflow, spillage. 3 built-in fire baffles protect drum contents from exterior ignition source.

OVAL SHAPE SAFETY CANS

Oval storage or dispensing cans save space. Available in stainless steel, terne plate or hot tin dipped. Safe, quick, filling or dispensing. Double wall fire baffles. Leather or Teflon gaskets.

FLAMMABLE STORAGE CABINET

Provides safe, convenient storage of flammable liquid safety cans at point of use. Removable, adjustable shelves. 45"x65"x18".

IN-LINE FLAME ARRESTER VENTS

Prevent flashbacks into tanks, process kettles etc. through vent opening. Complete, self-contained unit design simplifies inspection and maintenance. For 1", 2", 3" and 4" pipe. Write for Protectoseal Vent Catalog. Describes complete line of tank vents, fittings, accessories.

Write for the new Protectoseal RED BOOK. Contains flammables engineering fundamentals and complete line of safety containers and operating equipment.

THE PROTECTOSEAL COMPANY

1348 S. WESTERN AVE. • CHICAGO 8, ILLINOIS

LITERATURE . . .

Pumps, Fans, Compressors

Compressors.....Complete information on how Cooper-Bessemer can help you plan compression & power facilities. Bulletin, "Cooper-Bessemer Equipment for Chemical Plants."
10-11 *Cooper-Bessemer

Compressors.....Standard models or designed to your specifications in any size of compressor, either centrifugal or axial-flow types. Bulletin, "Joy Turbodynamics."
235 *Joy Mfg. Co.

Compressors, Reciprocating.....are available in a wide range of sizes for both oil-free and plant air service. Complete information contained in Bul. 349-11.
233 *Joy Manufacturing Co.

Compressors.....Ro-Flo compressors are available in 2-stage units in range from 250 to 1800 cfm. Single stage units from 40 to 3000 cfm. descriptive literature.
211 *Allis-Chalmers

Power Roof Ventilator.....Full information on the Clarage Centrilator and its exclusive Jet Siphon Air Flow Director feature contained in Bulletin 550.
140 *Clarage Fan Co.

Pump.....Full performance and dimensional information about Unipumps is contained in Bulletin No. 300. Available in capacities from 10 to 1700 g.p.m.
216 *The Weinman Pump Mfg. Co.

Pumps, Chemical.....Typical applications, flow charts, description & specifications of models of various capacities & constructions are contained in Bulletin 59.
107 *Lapp Insulator Co., Inc.

Pump, Gear.....Improved design . . . now 12 gpm. All wetted parts acid-resistant, wear-resistant Ace hard rubber. Complete information in Bul. CE-55.
229o *American Hard Rubber Co.

Pumps.....range from 25 to 2500 hp., pressures to 50,000 psi. Complete data on all types of pumps for the process industries is available on request.
48 *Aldrich Pump Co.

Pumps.....SRL (Rubber Lined) pumps offer high efficiency, low horsepower. Sizes to 5000 g.p.m. Additional information now available in Bul. P9-B10.
206i *Denver Equipment Co.

Pumps.....Durcopumps are produced in standard, self-priming & vertical submerged designs. Standard operating temperatures to 500 F. Literature on request.
185 *The Duriron Co., Inc.

Pumps, Acid.....Pumping parts available in a variety of metal alloys, as well as plastic, to cover a wide range of corrosive applications. Complete details.
255 *A. R. Wilfley & Sons, Inc.

Pumps, Diaphragm.....Sizes 1" to 10" simples and duples, capacity to 1000 g.p.m. Stroke can be adjusted while pump is operating. Details in Bul. P8-B12.
206g *Denver Equip. Co.

*From advertisement, this issue

LITERATURE . . .

Pumps, Sump.....Demersible pumps can be totally submerged without need of long support column or drive shaft. Pump & motor are one unit. Descriptive literature.
119 *The Deming Co.

Pumps, Vertical Centrifugal.....for handling frothy liquids or coarse, sandy slurries, constant or intermittent flow. Capacity to 450 g.p.m. Bul. No. P10-B5.
206h *Denver Equip. Co.

Services & Miscellaneous

Dust Control.....Complete range of dry collection equipment given in bulletin. Shows ways of using cloth filtration and cyclonic equipment for dust and pollution problems.
243A Dracco Div., Fuller Co.

Engineering Survey Service.....for a thorough appraisal of your needs by qualified chemists & engineers. Details are now available on your request.
68 *Industrial Filter & Pump Mfg.

Fabrication.....Bulletins HE and CI contain information on materials and designs . . . all working, welding and testing operations. Quality control on all fabricating.
13 *Downingtown Iron Works, Inc.

Flammables & Safety Equipment..... The new Red Book contains flammables engineering fundamentals & complete line of safety containers & operating equipment.
R241a *The Protectoseal Co.

Lubrication.....24-page brochure contains information on centralized systems of lubrication. Principles of operation and system components discussed. Illustrations included.
243B Farval Div. Eaton Mfg. Co.

Lubrication System.....The Accumite System is complete with fully automatic pump, metering valves & controls. All advantages of measured lubrication covered in catalog.
14 *Stewart-Warner Corp.

Metals.....Booklet discusses in 19 articles end uses of small diameter tubing, clad metals and composite wires. Includes article on platinum thermocouples.
243C J. Bishop & Co.

Pocket Respirator.....protects against organic vapors, acid gases, alkali gases plus dusts and mists by means of interchangeable cartridges & filter built into each cartridge.
53 *American Optical Co.

Safety Tools.....Non-sparking hand tools tested and approved by Factory Mutuals Laboratories are also non-corrosive and non-magnetic. Catalog is illustrated.
243D Ampco Metal, Inc.

Ventilating Systems.....Duracor ventilating systems & components provide outstanding resistance to attack from all types of corrosive fumes. New Ceilcote catalog.
238 *The Ceilcote Co., Inc.

Water Conditioning.....Data sheet discusses "whys" of keeping internal baffling in good condition for production of pure steam. Mechanical and chemical factors given.
243E Betz Laboratories, Inc.

*From advertisement, this issue

CLASSIFIED . . .

EMPLOYMENT OPPORTUNITIES

CE's nation-wide coverage brings you tips and information on current opportunities in job functions throughout the chemical process industries.

▶ **Coverage** — National Executive, management, engineering, technical, sales, office, skilled. Positions vacant, positions wanted, civil service, selling opportunities, employment agencies and services, labor bureaus.

▶ **Displayed Rates**—$54 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Subject to the usual agency commission.

▶ **Undisplayed Rates**—$2.10 per line, 3 lines minimum. To figure advance payment count 5 average words as a line; box number counts as 1 line. 10% discount if full payment is made in advance for 4 consecutive insertions. Not subject to agency commission.

▶ **Closing Date**—April 18th issue closes March 25th. Send new ads to Chemical Engineering, P. O. Box 12, New York 36, N. Y.

Armour Industrial Chemical Co.

Has Through Promotions and Expansion, Two Important Openings for Promotable Young Men.

PROCESS ENGINEER

for **evaluation, selection** and **design** of our process equipment. Ch.E degree with 3—5 years applicable experience with either **processors** or **engineering construction firms** will be suitable. Work involves diversified processes with a variety of unit operations and widely divergent conditions.

ASST. PLANT ENGINEER

for **supervision** of the **maintenance** function and the personnel involved. M.E., Ch.E. or Pet. E. Degree with 3—5 years supervisory maintenance experience in **petroleum** or **chemical processing** required.

If you feel prepared to step up to the responsibilities described above please write in confidence with full information to:

John W. Church, Personnel Manager
ARMOUR INDUSTRIAL CHEMICAL CO.
110 N. Wacker Drive
Chicago 6, Illinois

CHEMICAL & MECHANICAL ENGINEERS

GULF AREA

Positions open in heavy chemical industry for experienced Mechanical and Chemical Engineers, Chemists, and administrative personnel qualified by educational background and/or experience. Positions offer advancement opportunity, good working conditions with modern facilities, and a liberal, well-balanced employee benefit program.

Community offers excellent schools, good housing, and recreational facilities.

Personal interviews arranged for qualified applicants. Those interested submit complete resume' of past experience and education, along with college scholastic record to:

P-3855, Chemical Engineering
520 W. Michigan Ave., Chicago 11, Ill.

BUSINESS OPPORTUNITY

MANAGEMENT PERSONNEL

with limited capital

and/or INNOVATIONS

Successful ventures require interdependent specialization under modern economic conditions.

Profitable investment outlets may exist in association with people who possess both proven backgrounds and innovations.

Write for further information to

BENHARD ASSOCIATES
Dept. CH.E.
1123 Western Saving Fund Bldg.
Phila. 7, Pa.

CIRCLE A ON READER SERVICE CARD

MATERIALS TECHNOLOGIST

The Applied Research & Development Division of Republic Aviation has an important position available for a Senior Research Scientist. PhD preferred (MS acceptable) with record of accomplishment in bench-scale process and product development. Must be capable of conducting investigations and assuming supervision of laboratory programs for production of sample prototype quantities of advanced materials in these and similar areas: semiconductor refractories, phosphors, coating compositions, cermets and electro deposits.

Facilities at Republic are among the finest and include a new $14,000,000 Research Center in Farmingdale, Long Island, which is scheduled to open late this Spring. The Center will add a highly sophisticated environment making possible wider technical investigations, as well as stimulating entirely new avenues of scientific experiment.

Send resume in confidence to: Mr. George R. Hickman, Technical Employment Mgr., Dept. 39C-4

REPUBLIC AVIATION

Farmingdale, Long Island, New York

CHEMICAL ENGINEERS

Recent promotions in our Technical Department have resulted in openings for Chemical Engineers. We prefer two to four years experience in our own or allied industries but experience in other fields will definitely be considered. Due to our continued expansion, we feel that there is full opportunity for professional growth for anyone joining our Technical Department. Our plant is located in Southeastern North Carolina, near several beaches and other recreational facilities. Salary commensurate with experience and ability. Write to

Personnel Department
Riegel Paper Corporation
Carolina Division, Acme, N. C.

EMPLOYMENT PROBLEM?

When you are in need of specialized men for specialized jobs, contact them through an employment ad in this publication.

FOR ADDITIONAL INFORMATION

About Classified Advertising

Contact The McGraw-Hill Office Nearest You

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1301 Rhodes-Haverty Bldg.
JAckson 3-6951
R. POWELL

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350 Park Square
HUbbard 2-7160
M. J. HOSMER

CHICAGO, 11
520 No. Michigan Ave.
MOhawk 4-5800
W. HIGGENS

CLEVELAND, 13
1164 Illuminating Bldg.
SUperior 1-7000
W. B. SULLIVAN

DALLAS, 2
1712 Commerce St.,
Vaughn Bldg.
Riverside 7-5117
GORDON JONES
F. E. HOLLAND

DENVER
1700 Broadway
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WOodward 2-1793
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LOS ANGELES, 17
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HUntley 2-5450
R. YOCOM

NEW YORK, 36
500 Fifth Ave.
OXford 5-5959
H. T. BUCHANAN
R. P. LAWLESS
T. W. BENDER

PHILADELPHIA, 3
Six Penn Center Plaza
LOcust 8-4330
H. W. BOZARTH

PITTSBURGH, 22
1111 Oliver Bldg.
EXpress 1-1314
P. PIERCE

ST. LOUIS, 8
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68 Post St.
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CLASSIFIED . . .

EQUIPMENT SEARCHLIGHT

CE's Searchlight spots the big bargains in used, resale and rented equipment. Check this issue's listings—most complete in the field—for items you need now.

▶ **Coverage** — National. Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

▶ **Rates**—$21.75 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Ads acceptable only in display style.

▶ **Closing date**—April 18th issue closes March 25th. Send all new ads to Chemical Engineering, Classified Adv. Division, P. O. Box 12, New York 36, N. Y.

LOEB OFFERINGS

Autoclave: 50 gal. Struthers Wells, st. st.
Centrifugal: Tolhurst 20" st. steel (New).
Concentrating Table: Deister #14, 5' x 8'.
Dewaterers: Davenport 3A, bronze hd. 3 hp.
Disintegrator: Riets RD18P, 75 hp.
Dryers: Devine 2 x 4' vac. drum, st. steel.
Evaporator: Buflovak st. st. 94 sq. ft. Buflovak dbl. eff. model 850D.
Filter: Oliver precoat 12x2" st. steel.
Homogenizers-Disperser: Tri-Homo #10, #4
Kettles: st. steel, with and without ag. Dopp 150 gal. dbl. act. agitator.
Mills: Mikro, ISH, 5 hp. Day 3-roll high speed 14x30"
Mikro Atomizer type 5MA st. steel. Colloid, 3, 5, 20, 25 hp. Cog stain. steel, 10 hp.
Mixers: Dbl. and sgl. arms sigma blade. Dry Powder, various sizes. W. & P. size 14, 50 gal. jktd.
Mix-Muller Simpson 18" lab., 39½" Porto.
Pumps: Rotary, gear, centrif. vacuum.
Screen: Rotex model 41 st. steel.
Still: Double effect st. st. 11,83 gal.
Tablet Press: Stokes DD2, 23 station.
Truck Tanks: Stain, steel 1200, 1600 gal.
Vacuum Pumps: 42" and 72" stain. steel.

LOEB EQUIPMENT SUPPLY CO.
TELEPHONE Stirling 8-1421
820 WEST SUPERIOR ST. CHICAGO 22, ILLINOIS

CIRCLE B ON READER SERVICE CARD

MARCH SPECIALS

Abbe 5'x6' J'ktd. Ball Mill, chrome mang. steel.
Oliver United Rotary Vac. Filter 3'x2'.
SS J'ktd. Ribbon Mixer, 24 cu.ft., 10 HP mtr.
Rotex Sifter 20"x48", on high stand, w/½ HP mtr.
Gruendler "BB" Hammermill, Whirlbeater.
Ribbon Blenders, Steel & SS, all sizes, New & Used.
4 Mikro's-Bantam, #1SI, #2SI, #4, w/motors.
Gen. American 42"x120" Twin Drum Dryer.
Pfaudler 1500 gal. glass, closed top Tank.

WHAT HAVE YOU FOR SALE OR TRADE?
YOU CAN BANK ON

EQUIPMENT CLEARING HOUSE, Inc.
111—33rd Street Brooklyn 32, N. Y.
SOuth 8-4451—4452—8782

CIRCLE C ON READER SERVICE CARD

BUY ON TERMS!

316 S.S. HEAT EXCHANGERS

1—Alco Products 835 sq ft horiz. 200-1" O D tubes 16' long

3—Downington Iron Works, 52 sq ft each, 20-⅝" tubes 16' long

ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. · San Francisco 7, Calif.

CIRCLE D ON READER SERVICE CARD

CHEMICAL EQUIPMENT DIVISION

Raymond 3 Roll #3036 Hi-Side Mill
Buflovak 19 Shelf Vacuum Shelf Dryers
1000 sq. ft. Stainless Heat Exchangers (2)
Fletcher 30" Susp. S.S. 10/5 H.P. Centrif.
Fletcher 40" Susp. Steel Centrifugal
Oliver 5'3"x3' Stainless Precoat Filters
Sweetland #12, #10, #7 Filter Presses
Komarek Greaves 27" x 24" Presses
Nooter 750 gal. Steel Reactor 300 PSI
Link Belt 502-16 Roto-Louvre Dryer
8'x80' Rotary Dryer 316 S.S.
Traylor 11' x 155' Rotary Kiln
Vulcan 9'x100' Rotary Kiln
Standard 5'x45' Rotary Dryer
Mosser 4'x47' Rotary Dryers
Louisville 6'x50'; 6'x25' Steam Tube Dryer
F. J. Stokes 38A & 382A Tray Dryers
Stainless Tanks 100, 200, 350 gal.
Condensers 100 to 5000 sq. ft. Steel; Admir.
Pressure Vessels 300 to 4500 gal.
Towers and Columns 3' to 10' Dia.
J. H. Day 600# S.S. Jktd. Powder Mixer

HEAT & POWER CO. INC.
60 E. 42nd St., New York 17, N. Y.
310 Thompson Bldg., Tulsa 3, Okla.

CIRCLE E ON READER SERVICE CARD

2—5' x 8' BALL TUBE MILLS

2—5' x 8' Kennedy Van Saun Air Swept Ball Tube Mills with disc feeders, fans, piping, all motors and electric eye mill level controls.

R. C. STANHOPE, INC.
Tel. MU 2-3076 or MU 2-1898
60 E. 42nd St. New York 17, N. Y.

CIRCLE F ON READER SERVICE CARD

FOR SALE

HEAT EXCHANGERS—12 Units manufactured by Foster-Wheeler, 79 to 520 sq. ft. heating surface, type 316 SS tubes and crown sheets.

Mixer, Sprout-Waldron 165 cu. ft. cap., hvy duty, 20 HP TEFC Mtr. geared down to 40 RPM, dbl spiral ribbon.

2—SS Selectro 3 deck 18" x 4' screens, like new.

Rotex Mod. 41, 40" x 120" double deck screens.

Kux Mod. 25 Rotary Tablet Press, dbl. action.

Send us a list of your idle surplus

AARON EQUIPMENT CO.
9370 Byron Street
Schiller Park, Illinois
Gladstone 1-1500

CIRCLE G ON READER SERVICE CARD

FMC

ENGINEERED REBUILDING ADDS GREAT VALUE TO FMC EQUIPMENT!

REACTORS and PRESSURE VESSELS

Mojonnier S/S Vac. Pans; 3'x10'; 6'x12'
Nickel Clad Reactor; 7'x11'6"; Jktd. Agt.
Struthers Wells Type 316 S/S; 1000-2000 Gal
Pfaudler G1-Lnd; Jktd. Agtd. to 1000 Gals.
Lancaster S/S Lined Rotary Jacketed Reactor; 50" Dia. x 17'14" long
Three Stage Continuous Agitated Reactor, 3 Vessels 4'x20' in tandem
Dopp 650 Gal. C.I. Jktd. Agtd. Reactor
250 Gal. Hi-Pressure Forged Steel Reactor, Jacketed and Agitated; 40" x 72"

PLASTIC and RUBBER EQUIPMENT

F-B Late Style 2 Roll Rubber Mills, 14"x30"; 16"x42"; 18"x42"; 22"x60"
Three Roll Calender; 22"x58" complete
Baker Perkins Hv. Duty Mixers to 300 Gal.
Banbury Type "B" Laboratory Mixer
Two Adamson Vulcanizers; 16' long
Abbe Pebble Mills with Motors, Pebbles; 37"x48"; 45"x48"; 60"x72"; 8'x8'
Truck Dryers; 11'x15'x30'; 7'x12'x100'
Automatic Mechanical Dryer; 160' long
Automatic Washer for Latex Pads
Southwark Hydraulic Presses; 36"x36"
Dunning & Boschert Hydraulic Presses 36"x36"
French Oil Mill Presses; 28"x30"
Stokes Aut. Molding Press No. 252; 300 Ton
Extruders: Royle 1 .1 ; Allen No. 2; NRM 1½"
Kux, Stokes & Colton Tablet Presses

FILTERS and FILTER PRESSES

Shriver and Sperry Filter Presses to 42" in Cast Iron, Stainless, Ni-Resist, Aluminum
Oliver Continuous Rotary Panel Type Vacuum Filters; 8'x8' and 8'x10'
Feinc String Type Rotary Vacuum Filters 6'x6' & 8'x10'; Stainless contacts
Bird Young Rotary Vacuum Filters 4'x4'
Sweetland Pressure Filters No. 2 to 12
Enzinger Vertical Stainless Pressure Filter; 18"x26"; ASME; 24 sq. ft.
Stainless Nutsche Type Filter 6' Dia. x 2'
Bowser Filter with Pump; 2000 GPH; 69 sq. ft.
Enzinger Leaf Type Filter, 48"x57" Tank with 15 leaves; 360 sq. ft. surface.

DRYERS and EVAPORATORS

Stokes Rotary Jktd. Dryer; 18'x8'
Stainless Lined Rotary Dryer; 50"x20"
B & S Dbl. Drum Dryer; 28"x60"
Buflovak Dbl. Drum Dryer; 40"x120"
Zaremba INCONEL Dbl. Effect Evaporator
Swenson Multi Effect Long Tube, Film Type Evaporators

FATTY ACID DISTILLATION SYSTEM

including Ni-Resist Still Pots
Monel and Steel Tanks, Stainless
Heat Exchanger, Condenser, Receiver,
Boiler, Jet and Booster Ejectors,
Pumps, Filters, Accessories.

CENTRIFUGES and EXTRACTORS

Bird Continuous Conical Horizontal Centrifuges; 18"; 24"; S/S; Monel
Sharples H2 Nozzlejector; 15 HP
Sharples Monel Model M4 P Centrifuge
DeLaval Type 316 S/S Hermetic Separator
Fletcher 12" and 30" S/S Centrifugals
Rubber Covered Centrifugals; all sizes

OUTSTANDING SELECTIONS

J. H. Day 40 Gal. Pony Mixers
J. H. Day Hi Speed 3 Roll Mills
J. H Day 200 Gal. Paragon Mixers
Stainless Heat Exchangers to 1000 sq. ft.
S/S Patterson-Twin Shell Blender 150 cu. ft.
Pfaudler Glass Lined Jacketed Thimble Condenser; 26 sq. ft.

Send for "FIRST FACTS" containing complete LISTINGS

FIRST MACHINERY CORP.
209-289 TENTH ST.
BROOKLYN 15, N. Y.
Sterling 8-4672

CIRCLE H ON READER SERVICE CARD

FOR "IMPOSSIBLE" BUDGETS

1—Niagara 36H192 Horizontal Filter 192 sq ft S.S. leaves

4—Hersey 6' x 30' Rotary Dryers. Comp w/Blowers. Hoods etc.

3—Stearns-Rogers 8' x 40' Rotary Dryers, ½" shell. Blowers. Hoods

2—Abbe 54" x 42" Porcelain Lined Pebble Mill. 186 gal. work. 5 HP

1—Patterson 6' x 8' Porax Lined jcktd Pebble Mill. 25 HP Expl.

1—Kent 6" x 14' 3 Roll Mill. Water cooled rolls. 5 HP expl mtr.

3—Lee 100 Gal S.S. Jacketed Kettles, with covers. 40 PSI

1—Day Imperial Mixer, 50 gal. work. cap. Sigma blade, jcktd

For immediate quote, wire or phone collect—GA 1-1380

ME MACHINERY AND EQUIPMENT COMPANY
123 Townsend St. · San Francisco 7, California

CIRCLE J ON READER SERVICE CARD

SAVE ON GOOD USED MACHINERY

Centrifugals: 12", 30", 40" & 48".
Centrifugals: Sharples #5 & #6 Stainless.
Dryers: Hersey 5'x26' Rotary, 316 Stainless Lined Buffalo Vac. Drum Dryer 24"x20". Lydon elec. heat Dryer 8 trays. Despatch Ovens Elec. Heated. Devine Vac. 8 shelf Dryer 38" x 42".
Filters: Vallez 49 S. S. covered leaves. #2 Sweetland 12 Stainless Leaves.
Filter Presses: 8" to 36" Iron & Wood.
Kettles: S.S. Jack. 20 to 500 gals. Dopp 350 gal. cast iron jack. Vacuum. Devine Impreg. Units 30" & 36" dia. Steel Alum. & Copper 5 to 2,000 gal.
Mills: Raymond #00, 30 HP. & #0000. Mikro Pulverizers #4, 2, 1, & Bantam.
Hammer Mills & Pulverizers 3 to 50 HP. Rotary Cutters 1½ to 5 HP. & up. Spr. Waldron Stainless spike crusher. Pebble, Jar & Ball Mills, Lab. to 6' x 8', 3 Roll, 9" x 32", 12" x 30", 16" x 40". Lehman 4 Roll W.C. 12' x 36" Steel. Colloid Mills 1½ H.P. & up.
Mixers: Baker Perkins jack, 100 gals. Day Imperial 75 & 150 gals. Change Can Mixers 8, 15, 40 gals. Day Jumbo 700 gal. horiz. mixer. Blystone 3000# horiz. spiral mixer. Day 1000# Ribbon Mixers, 6 up to 3000#. Lancaster 6' dia. 25 HP. & #1, HP.
Pumps: Stokes etc. Vac. 10 to 500 CFM. Gould 75 HP. Centrifugal 250 PSI.
Sifters: Day, Robinson, Rotex type.
Tablet Machines: Stokes Rotary RB2 & RD3. Single & Rotary ½" to 3".
New 14" x 30" Rubber & Plastic Mills.
Hydr. Presser, Plastic & Rubber Machy.

Partial Listings. Write for Bulletins

STEIN EQUIPT. CO.
107-8th St., Brooklyn 15, N. Y.
Sterling 8-1944

CIRCLE K ON READER SERVICE CARD

PIPE

2,000,000 ft. 2"	3.50# to the foot
1,000,000 ft. 3"	7.70#
1,000,000 ft. 4"	10.96#
500,000 ft. 6"	19.80#
200,000 ft. 8⅝"	28#
400,000 ft. 10¾"	35#
75,000 ft. 12¾"	40#
10,000 ft. 16"	42#

All No. 1 Grade Plain End and Cleaned
INDIANA-OHIO PIPE CO.
P.O. Box 5412 Shepard Sta. Phone CL 3-8527
COLUMBUS 19, OHIO

CIRCLE L ON READER SERVICE CARD

Baker Perkins 150 gal 40 HP, 100 gal 50 HP. Both S.S. 2 arm jacketed vacuum hdr. tilt.

Aluminum Condenser 350 sq ft.

Aluminum Evaporator Calandria type, never used. 1300 sq feet tube area.

Continuous Stripping column 2 x 13 Steel.

Hydraulic Pumps & Motors.

Dryers Vacuum Shelf.

MACHINECRAFT CORPORATION
800 Wilson Ave. (East of Doremus)
Newark 5, N. J. MI 2-7634

CIRCLE M ON READER SERVICE CARD

DIESEL LOCOMOTIVES & CRANES

3—New 25 Ton, 2 GE I Whitecomb.
3—23 Ton, 2-45 Ton Used Gen. Elec.
1—14 Ton, 1-80 Ton Used Gen. Elec.
1—100 Ton, Alco Used, New 1955.
3—100 Ton, Gen. Motors, Used
1—25 Ton, Industrial 60' Boom Loco. Crane.

PLANT EQUIPMENT

2—Wemco 2M-HMS-Plants.
36 x 42 Jeffrey Hammermill, Type B-2.
No. 5060 Dixie Mogul Hammermill 500 H.P.
2—6' x 36" Hardinge Ball Mills.
2—5' x 8' Kennedy Van-Saun air swept Ball Tube Mills with Motors & Elec. Eye.
7' x 24' Allis-Chalmers Tube Mill.
5' x 10' & 7' x 15' Red Mills.
2" x 6" Sturtevant Lab. Jaw Crusher, 2 HP motor
14" x 28" New England Jaw Crusher
30" x 36" Traylor Type H Jaw Crusher
48" x 72" Buchanan Type "C" Jaw Crusher
56" x 72" Traylor Style G Jaw Crusher
No. 1 Sturtevant Rotary Fine Reduction
2' Symons Standard Cone Crusher.
36" x 20' Ruggles Coles Class XF-1 Rotary Dryer.
#207-10 & #705—24 Link Belt Rota Louver Dryers.
Link-Belt Mono-Tube 24-10 Dryers
54" x 35' Louisville Monel Steam Tube Dryer.
72" x 28' Madsen Rotary Dryer.
5' x 30' Ruggles Coles Class XA-8 Rotary Dryer.
8' x 60' Rotary Dryer ½" Welded Shell in Calif.
9' x 160' Vulcan Rotary Kiln
42" x 18" Traylor Type AA Crushing Rolls.
5'6" x 60' Rotary Dryer or Cooler.

R. C. STANHOPE, INC.
60 E. 42nd St. N. Y. 17, N. Y.
Tel. MU 2-3075

CIRCLE N ON READER SERVICE CARD

COMPRESSORS

World's Best Rebuilts

74 CFM	1500 PSI	6¼-3¾-1½x7 CP. TCB3
100 CFM	150 PSI	6x7 Ing. ES-1
104 CFM	2500 PSI	6¾-4¼-1 11/16x9 IR-ES3
110 CFM	3000 PSI	Ing. GC 50BW
138 CFM	100 PSI	7x7 Ing. Rand ESI
151 CFM	3000 PSI	13¾x12 Norwalk TRS-4T
238 CFM	100 PSI	9x9 ING. ES Worth HB
311 CFM	1500 PSI	10½-7½-3½x13 IR-ES3
465 CFM	100 PSI	12x11-IR-ES-1-Chic. P.T.
562 CFM	125 PSI	12x13 Chic. T
686 CFM	100 PSI	14x13 Ing. ES-Chic. P.T.
823 CFM	Vac.	18x7 Ing. ES-1
877 CFM	125 PSI	17-10½ IR. XRB
2360 CFM	50 PSI	19-19x14
3135 CFM	Vac	31x13 Ing. ES Worth HB
3078 CFM	110 PSI	30-18x21 Ing. JRE2
500 HP	Syn	3-60-2300/4000

AMERICAN AIR COMPRESSOR CORP.
Chem. Road, North Bergen, N. J. UNion 5-1397

CIRCLE O ON READER SERVICE CARD

OVER 5,000 MACHINES IN STOCK

FOR EVERY INDUSTRY AND PURPOSE

- Wrappers
- Packaging machines
- Cartoning machines
- Fillers
- Labelers
- Filter presses
- Roller mills
- Mixers
- Pulverizers
- Grinders
- Dryers
- Sifters
- Cappers
- Tablet machines

TELL US YOUR REQUIREMENTS

Complete Details And Our Special Low Bargain Prices Available On Request

UNION STANDARD EQUIPMENT CO.
318-322 Lafayette St., New York 12, N. Y.
Phone: Canal 6-5333-4-5-6

CIRCLE P ON READER SERVICE CARD

BALL MILLS—3' x 12' Abbe/40 HP—4' x 6' Allis Chalmers 60 HP Slip Ring/screwfeeder—Kennedy Van Saun 5' x 6' Enclosed gears/50 HP/scales/feeders/exhausters—Hardinge 6' x 12' w/200 HP Slip Ring/drum feeder.

HAMMERMILLS — 20 HP Gruendler X — 30 HP Mikro 3W—40 HP Jeffrey 24 x 20—50 HP Wms. AKBX—100 HP Jeffrey 36 x 42—450 HP Penna SXT 14.

ROTARY DRYERS—24" x 22'—36" x 24'—44" x 25'—5' x 50' (2) all w/motor drives—burners/blowers avail.

VACUUM PUMPS—115 CFM Beach Russ 100 RP w/5 HP motor/Vee belt drive.

SCALES—12500# capacity dial—Fairbanks Printomatic—8' x 6' Platform.

FEEDERS—Syntron FMI,—FM3—w/hoppers/vibrators/controls.

YOUR BEST REBUILT MACHINERY SOURCE

LAWLER COMPANY
Durham Ave. Liberty 9-0245 Metuchen, N. J.

CIRCLE Q ON READER SERVICE CARD

VALUES GALORE—BUY NOW!

Fletcher 30" Type 316 S.S. Sus. Style Centrifuge.
Day #31 Reball Sifters, all S.S. 20" x 48".
Spiral Jacketed Mixers, 600 & 1000#, Stainless Steel.
Raymond 36" Whizzer Air Separator.
Rotocione Size 16, Type W.
Sturtevant 2 x 6 Open Dr. Lab. Crusher 5 HP.
Jeffrey Traylor S.S. Double Deck Vib. Screen 30" x 68".
Shriver 30" C.I.F.P. 30 Ch. 1" Cake.
Kettles S.S. Jack. 50 to 100 Gals.
Tanks S.S. 100 to 600 Gals. Cap.
Autoclave S.S. 30 Gals. 400 psi. w/Pulsator.
Cyclotherm Boiler 620# hr. @250 psi.
Conveyors, Labelers, Agitators, etc.

We buy your surplus. Send us your inquiries.

The Machinery & Equipment Co., Used Div.
Haring Equipment Corp.
91-93 New Jersey R.R. Ave. Newark 5, N. J.
Market 2-3103

CIRCLE R ON READER SERVICE CARD

TANK TRAILERS

FOR CHEMICALS

Stainless Steel - new and used.

HACKETT TANK COMPANY, Inc.
P.O. Box 803, Packers Sta., Kansas City, Kans.
MAyfair 1-2363

CIRCLE S ON READER SERVICE CARD

STAINLESS STEEL TANKS

Oxygen cylinder, J-1, 24" x 45", 77 gal., 18,000 cu. in., 400 PSI 10 gauge, type 304. Value $300.

Brand NEW $99.50
Ship. wt. 250 lbs.

Model F-1, 8½" x 18", wt. 14 lbs., 1,000 cu. in. type 302 and 304, gauge 16. Packed 8 to carton. **$14.50 NEW**

Air Force surplus. Ideal for chemicals, gases, pneumatic use, hydraulic, liquids, etc. Prompt shipment. Terms 30 days net, F.O.B. Baton Rouge, La.

ILLINOIS MFG. & SUPPLY CO.
1829 S. State Street, Chicago 16, Illinois, Dept. 10
Phone VIctory 2-6633

CIRCLE T ON READER SERVICE CARD

"OUTSTANDING VALUES"

LOUISVILLE STAINLESS DRYER

96" dia. x 80' long. ½" shell. type 316 Stainless Steel Clad. Type 316 S.S. ilights. Fully equipped. 50 HP Motor and Reduction unit drive.

Wire or phone collect—GA 1-1380

ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. · San Francisco 7, Calif.

CIRCLE U ON READER SERVICE CARD

LIQUIDATING

FORMER FELDSPAR MANUFACTURING FACILITIES

BON AMI, INC., MANCHESTER, CONN.

2—Hardinge 7' x 36" conical pebble mills

19—Abbe Eng. 6' x 8' pebble mills, 30 HP drives

2—Buchanan 13" x 24" jaw crushers, 50 HP

1—Pangborn dust collector and 15 HP exhauster

1—Dings Magnetic Separator

2—Symons 3' shorthead cone crushers, fine bowl

1—Christie 4'-6" x 45' long rotary spar dryer, complete

1—Allis-Chalmers 6' x 18' pebble mill, buhrstone lined

5—Bucket elevators, up to 40' high, on rubber belts

SEND FOR CIRCULAR

STAINLESS STEEL TANKS

1—17,650 gal., horiz., T316 SS, 9' x 36', ¼" shell, ⅜" dished heads, 40# WP.

1—10,000 gal., horiz., T304 SS, 8' x 26', cone heads.

1—3700 gal., vert., T304 SS, 6' x 17', VACUUM, int. coils.

1—3400 gal., horiz., T304 SS, 6'6" x 16', ¼" shell, 7/16" dished heads.

1—3300 gal., vert., T304, SS, 6' x 14'6", ⅜" shell, ⅜" heads, 70# WP.

1—2830 gal., horiz., T316 SS, 6' x 12', 5/16" shell & dished heads, VACUUM

3—2750 gal. vert., T316 SS, 7' x 8' dished heads, 50# WP. 75 sq. ft. coil.

6—2600 gal. vert., T316 SS, 7' x 8', flat bottom, 19# WP, 5 HP agit.

1—2500 gal., vert., T316 SS, 7' x 7', ¼" shell, 5/16" dished heads, 70# WP.

6—2250 gal., vert., T316 SS, 7' x 6'3", dished heads, 70# WP, 5 HP agit.

1—1900 gal., vert., T316 SS, 6' x 8', ⅜" shell & dished heads, VAC. or 100#

12—1750 gal., vert. hoppers, T304 SS, double cone bottom.

4—1200 gal., vert., T316 SS, 5' x 7', cone bottom, VACUUM.

1—1,000 gal. vert., T316 SS, 5' x 7', ¼" dished heads.

100—Tanks & vessels, 100 to 1000 gal., all types, etc.

BUBBLE-CAP COLUMNS T316 STAINLESS STEEL

1—110" dia. Vulcan—10 trays

2—96" dia. Vulcan—30 trays

1—96" dia. Vulcan—10 trays

1—60" dia. Vulcan—10 trays

1—48" dia. Vulcan—25 trays—T304 ELC

1—42" dia. Vulcan—Packed—32' high

1—36" dia. Vulcan—6 trays

1—24" dia.—Packed—28' high, T304

HEAT EXCHANGERS—CONDENSERS

1—2000 sq. ft., T316 SS condenser

1—1960 sq. ft., T316 SS exchanger

8—800 sq. ft., T316 SS condensers

60—T316 SS condenser & exchangers, 1450, 800, 735, 427, 400, 300, 264, 250, 235, 200, 165, 150, 125, 110, 47, 30

25—Copper & Cupro-nickel exchangers & condensers, up to 1070 sq ft.

FILTERS—CENTRIFUGALS

1—Niagara #510-28, 510 sq. ft. vert. leaf, T316 SS.

1—Alco 110 sq. ft., T316 vert. filter.

1—Sparkler #33-S-28, 151 sq. ft. horiz. plate, T304 SS.

1—Eimco 18" dia. x 24" face T304 SS rotary vacuum

2—Oliver 5'3" dia. x 3' face rot. vac., pressure precoat, T316 SS, ASME 30# pressure housing.

1—Oliver 5'3" dia. x 8' face rot. vac., precoat, steel. UNUSED.

8—Sharples #AS-16V super cent. Inconel, Vapor-tite.

2—Sharples #16P, T304 SS pressure-tite centrifugals.

3—Sharples #C-20 Super-D-Hydrators, T316 SS.

2—Bird 18" x 28" horiz. cent., T304 SS.

1—Bird 32" x 50" horiz. cent., T316 SS.

2—Sperry 30" P. & F. filter presses, 19-9 st. st. (NI-RESIST).

BEST BUYS

1—Kennedy Van Saun 7' x 9' contin. ball mill—150 HP.

12—4500 gal. nickel-clad tanks, 8' dia. x 11' high, cone bottom, 125# WP.

1—Struthers-Wells 630 sq. ft. T316 SS evaporator.

3—18,000 gal. Aluminum cone-bottom tanks, 12' dia. x 31' OAH.

1—Link-Belt #604-18 roto-louvre dryer, cyclone, fan, etc.

3—Worthington 160 ton steam-jet vacuum refrig. units.

2—Buffalo T316 SS Blowers, 2330 cfm, 60 HP TEFC. Motor.

2—1800 cu. ft. Read T304 SS weigh hoppers, with scales, T304 SS screw conveyor, bucket elevators, AJAX "Le-veyor" shaker conveyors.

1—Vulcan 10' x 11' x 175' long rotary kiln, 13/16" shell, 2-tire.

1—Bartlett & Snow 3' x 15' everdur rotary dryer.

PERRY EQUIPMENT CORPORATION

1413-21 N. SIXTH ST. PHILADELPHIA 22, PA.

Phone POplar 3-3505

CIRCLE Y ON READER SERVICE CARD

YOU'RE RIDIN' HIGH
When You Buy
GELB
CHEMICAL PROCESS EQUIPMENT

1—18,000 gal. type 316 SS pressure tank, 60 psi
1—Eimco type 316 SS rotary vacuum drum filter, 3' x 1', complete
5—Pfaudler Series XL 1000 gal. glass lined jacketed reactors, complete with drives and anchor type agitators.
3—Struthers Wells type 316 SS jacketed reactors, 2000 gal. with agitators and drives, 40# internal pressure

AUTOCLAVES, KETTLES AND REACTORS

1—Aluminum 16,000 gal. horiz. storage tank
1—Type 316 SS 2000 gal. horizontal tank
1—Edgemoor type 316 SS 750 gal. jacketed reactor
1—Pfaudler Series EL, glass lined jacketed reactor, 300 gal. complete with anchor type agitator and drive
2—Pfaudler 200 gal. glass lined jacketed, reactors complete with anchor type agitators and drives
1—Pfaudler 100 gal. glass lined jacketed reactor, complete with anchor type agitator and drive
1—Pfaudler 100 gal. glass lined vacuum receiver
1—Steel and Alloy Tank Co. 100 gal. type 347 SS pressure tank, 250 psi jacket
1—Blaw Knox 400 gal. steel jacketed autoclave, 570# internal pressure, 85# jacket
1—Blaw-Knox 45 gal. jacketed autoclave, 1500# pressure
1—Paterson Kelley 6000 gal. steel jacketed kettle

DRYERS

3—Link Belt steel roto louvre dryers, Model 207-10, 310-16, 604-20
1—Buflovak stainless steel rotary vacuum dryer, 3' x 15'
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
2—Louisville rotary dryers, 8' x 50', SS
1—Louisville rotary steam tube dryer, 8' x 45'
1—Louisville rotary dryer, 38" x 48', Type L
1—Traylor 4' x 40' rotary dryer
1—Rotary dryer, 6' x 36'
2—Stokes Model 138J-20 single door vacuum shelf dryer, 20 shelves, complete
1—Western Precipitation Corp. SS pilot spray dryer, Type N-2
4—Gordon single truck tray dryer

FILTERS

3—Dorrco rubber covered filters, 6' x 2'
1—Sweetland #3 stainless steel filter
12—Sweetland #12 filters with 72 SS leaves
1—Niagara SS filter, Model 510-28
1—Oliver SS rotary pressure precoat filter, 5'3" x 8'
1—Oliver horizontal filter, 3'
10—Shriver plate and frame filter presses, 12" to 42"
1—Shriver aluminum 30" x 30" P&F filter press, 30 chambers
1—Shriver C. I. plate and frame filter press, 36" x 36", closed delivery, 4 eye, 60 chambers

CENTRIFUGES

1—AT&M 26" suspended type centrifuge with SS perforated basket, complete with plow and motor
1—AT&M 48" SS suspended type centrifuge, complete with plow, motor and imperforated basket

THE GELB GIRL—MARCH 1960

2—Fletcher 40" center slung rubber covered centrifuges with perforated baskets and motors
1—AT&M 40" SS suspended type centrifuge, complete with motor and plow with perforated basket

MIXERS

15—Robinson type 304 SS horizontal blenders, 255 cu. ft.
1—Baker Perkins size 16 type TRM, 150 gal., jacketed double arm sigma blade mixer with vacuum cover
3—Robinson type 316 SS sigma blade jacketed h.d. mixers, 400 gal.
1—Baker Perkins Size 20, 2000 gal. double arm jacketed vacuum mixers with double naben blades
1—Entoleter impact mill type PPM-27
1—Stokes SS granulating mixer, Model 21-J
3—Banbury #1 mixers, chrome plated rotors, with 50 HP motors
1—Baker Perkins size 16, type UUEM, 150 gal. jacketed double arm dispersion type mixer, complete with compression cover and 100 HP motor

MISCELLANEOUS

1—Cleaver Brooks 500 HP package steam generator, 200#
1—York Shipley 175 HP package steam generator, 135# psi
1—Badger type 316 SS bubble cap column, 42" dia. with 11 trays
1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
1—Vulcan SS bubble cap column, 4' x 28 plates
1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
1—Condenser Service type 316 SS heat exchanger, 350 sq. ft.
3—Badger type 316 SS heat exchangers, 500 sq. ft. and 600 sq. ft.
1—Downington type 316 SS heat exchanger, 750 sq. ft.
2—Swenson type 316 SS vacuum crystallizers, 3'6" x 12', 2' x 12'
3—Williams type 316 SS hammermills, Model AK
1—Sprout Waldron Model 501-D pelleter
1—Ross 6" x 14", 3 roll paint mill, complete
2—Sweco 48" SS separators, Model D-2D-8
1—Stokes stainless steel coating pan, 3' dia.
50—Steel heat exchangers, 15 sq. ft. to 100 sq. ft.
4—Stokes tablet presses, Model T and R, with drives and motors

2—Sturtevant #7 SS dust type rotary batch blenders, new
4—Tolhurst 40" center slung rubber covered centrifuges with perforated baskets and motors
1—Pfaudler Series R, 300 gal. glass lined jacketed reactor, with impeller type agitator and drive, 125# internal pressure 85# jacket
15—Davis Engr. SS heat exchangers, 145 sq. ft. (new)

R. GELB & SONS, INC.
U. S. HIGHWAY 22, UNION, N. J. · MURDOCK 6-4900
75 ANNIVERSARY

CIRCLE Z ON READER SERVICE LINE

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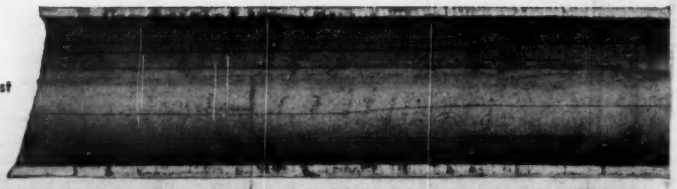
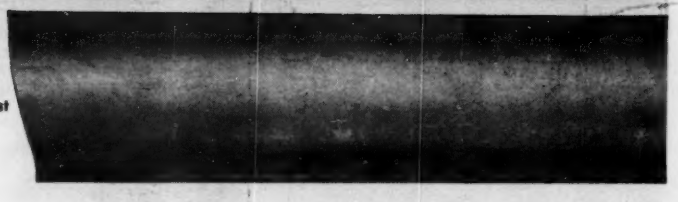
Inside surface of Carpenter Stainless Tube after test



Carpenter stainless condenser tubes score impressive win in 8700-hour run

Outside surface of Carpenter Stainless Tube after test



To determine the suitability of various materials for retubing its surface condensers, a large Eastern power company subjected Carpenter Stainless Tubes to an actual service test of 8700 hours in the corrosive cooling water condition shown below. When removed for checking their performance, the tubes showed no ill-effects from this punishing test. Not the slightest trace of corrosion or scale was visible on their inside or outside surfaces as shown above.

Evidence keeps piling up in favor of Carpenter Stainless Tubes for condensers and heat exchangers subjected to corrosive conditions. Now promptly available from our large mill stocks are Types 304 and 316 condenser and heat exchanger tubes of ⅝" to 1" O.D., 16 and 18 BWG, in lengths up to 40 ft.

COOLING WATER

pH	6.7 — 7.5
Chlorides	1,500 — 15,000 ppm
Sulfate	400 — 2,000 ppm
Magnesium	300 — 1,000 ppm
Calcium	100 — 350 ppm
Bicarbonate	100 — 150 ppm
Suspended Matter	500 — 2,500 ppm
Total Solids	20,000 — 28,000 ppm
Oxygen	1 — 8 ppm
Sulphides and Sulphates	Indeterminate but present

Take advantage of Carpenter experience, know-how and cost-savings on your corrosion control problems. Contact our nearest office for technical assistance and helpful engineering data. The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

your master key to cost-savings in power equipment

Stainless Tubing & Pipe

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ACID PUMPS

1" TO 8" DISCHARGE SIZES!

10 TO 3000 GPM CAPACITIES!

ALLOY OR PLASTIC PARTS!

Whatever your pumping job requires, there is a Wilfley Acid Pump to handle it—dependably, economically. Wilfley's simplified packingless design and rugged construction guarantee trouble-free operation, higher output, longer pump life. *And, to give you maximum pumping economy, every Wilfley installation is* JOB ENGINEERED.

Pumping parts are available in a variety of metal alloys, as well as plastic, to cover a wide range of corrosive applications.

Write, wire or phone for complete details.

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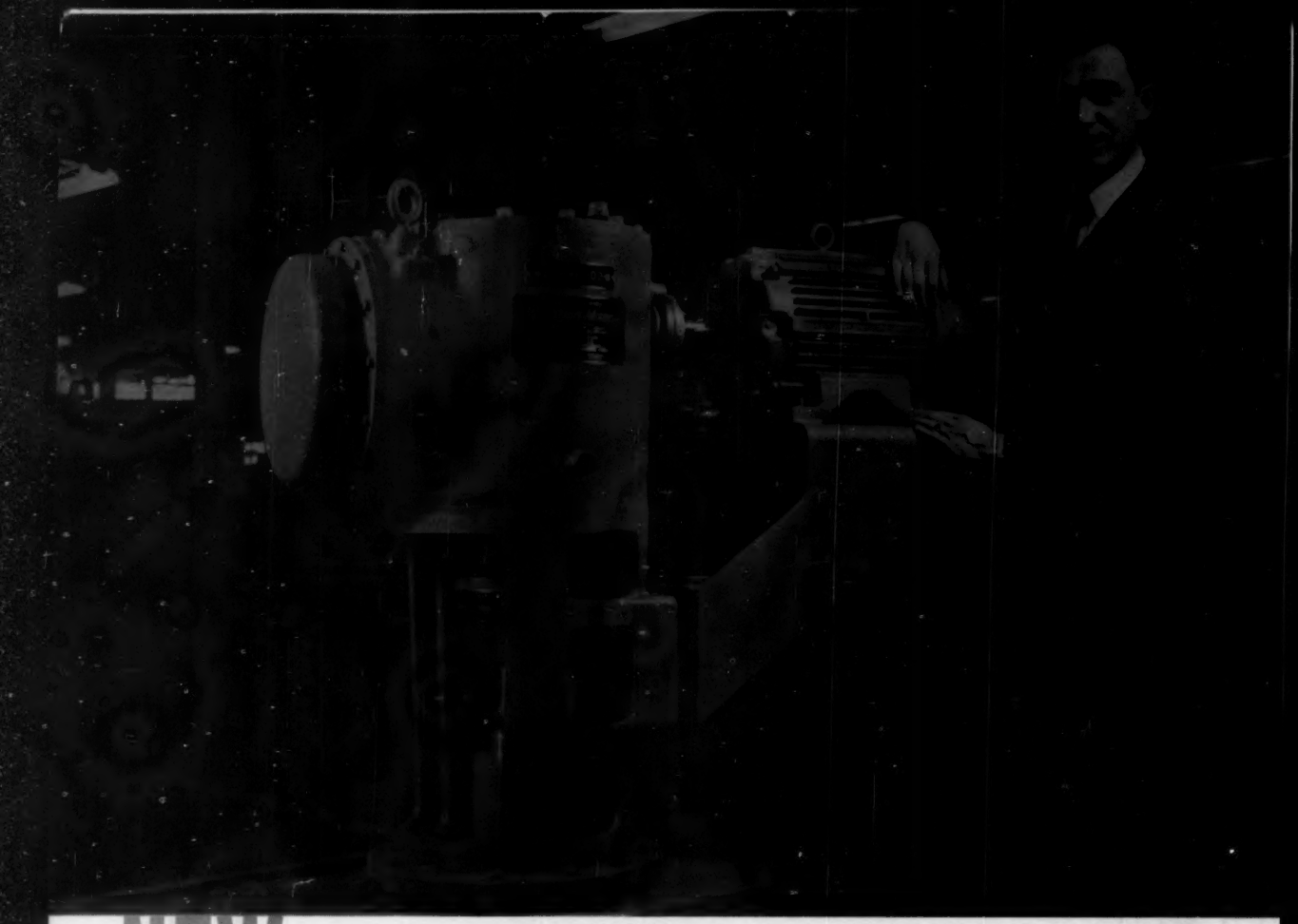

SERIES RE comes in a full range of mixer sizes and mountings for open or closed tanks.

NEW LOW-COST MIXER

Here's how to save money on fluid-mixing operations that don't demand the ultimate in shutdown insurance

In the new lower-cost Series RE LIGHTNIN Mixer, you get all the advantages of LIGHTNIN construction except for hollow-quill drive. The speed-reducer output shaft is coupled directly to the mixer shaft, rather than through a flexible coupling as in the regular Series E LIGHTNIN Mixer.

Because of this one difference, we DO NOT recommend the new Series RE line for critical operations in which an accidental overload on the mixer shaft could cause a costly drive failure. In such applications, our regular Series E design gives you maximum protection against process shutdown—a degree of insurance you get with no other mixer.

For any job that doesn't demand this high level of protection, you'll find the new Series RE LIGHTNIN Mixer hard to beat on first cost—and on performance.

It's the only mixer in its price range that gives you all these advantages:

1. Efficient right-angle drive—in all models
2. Low-headroom shape—in all models
3. Easy-to-get-at change gears—in all models

Plus: Precision bevel drive gears. Shaft bearings spaced to keep span and deflection to a minimum in accord with AGMA standards. Speed quickly changeable in case process requirements ever change. Splash lubrication throughout. Dry-well leak prevention. Many other refinements such as weatherproof oil-level gauge, weatherproof breather, clear-flow crankcase drain nipple, conveniently placed neoprene-covered grease fittings.

You can get the new Series RE in a full range of sizes, in your choice of *six* different mountings for open or closed tanks, and in literally hundreds of standard power-speed combinations. Wetted parts in carbon steel, 304 and 316 stainless steels are carried in stock.

Get the story now. Ask your LIGHTNIN Mixer representative to show you how new Series RE gives you more mixer than ever for the money—and where you can apply it for greatest savings. He's listed in Chemical Engineering Catalog and in the yellow pages of your telephone directory. Or write directly to us.

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